ROADS AND STREETS

A Gillette Publication—Established 1906

Vol. LXXVII *Chicago, May, 1934* *No. 5*

8.9 Mile Highway Contract Requires 1,166,000 Cu. Yd. Excavation

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GRADING work on the so-called American Canyon Cut-off began on Oct. 9, 1933. Up to April 1, 1934, three power shovels, which have been working on the big cut and loading into trucks, had moved approximately 335,000 cu. yd. of the estimated 520,500 cu. yd. total to be taken from this cut, which represents nearly one-half of the total estimated 1,166,000 cu. yd. of excavation on this 8.9 miles project. In addition, another power shovel and three scrapers pulled by tractors have moved an additional 310,000 cu. yd., making the total excavation moved to April 1, 645,000 cu. yd.

Why the Cut-Off Is Being Built.—This highway change has been under consideration for several years as a very necessary improvement to replace the present indirect and inadequate route, between Cordelia and the recently built Carquinez Toll Bridge across Carquinez Straits, an arm of San Francisco Bay.

When the state highway system was originally laid out, the only means of crossing the Straits was by toll ferry between Benicia and Martinez, this fixed the terminus of the primary highway Route 7 between Sacramento and San Francisco at Benicia. Another important road, Route 8, laid out connecting with Route 7 at Cordelia, crossed a spur of the Coast Range through the Jameson Canyon, and then through Napa and to Route 8 north of San Francisco. A county road connected this Route with Vallejo.

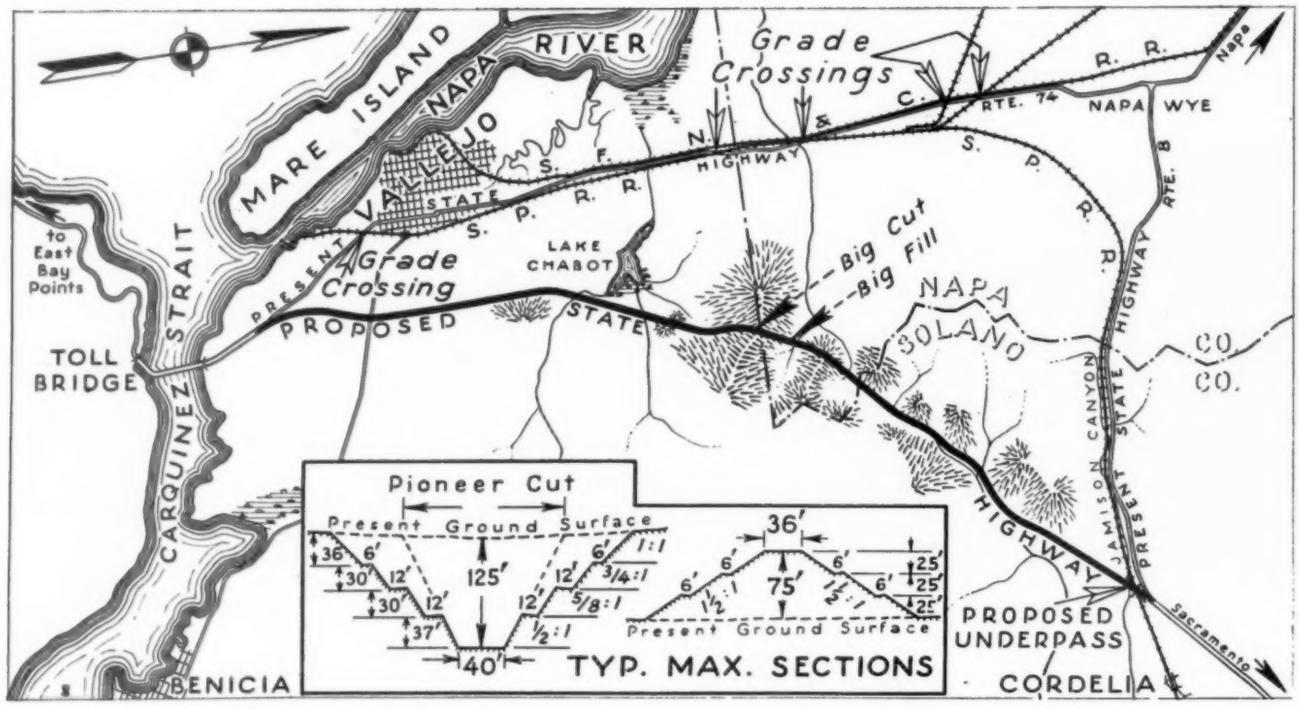
Private interests realizing that the existing route was inadequate for the traffic, put into operation a toll ferry across the Carquinez Straits between Vallejo and Valona, which shortening the distance, attracted most of the traffic from the Central Valley, via Route 8, the county road and through Vallejo.

The Carquinez toll bridge, replacing the ferry, was later conceived and put through by the same interests who operated the ferry.

The present road from Cordelia through the Jameson Canyon to the bridge is indirect, has five railroad grade crossings and traverses several blocks of city streets in Vallejo, the alignment is poor and the traffic is slowed down by these conditions.

The New Route.—The American Canyon Route with direct alignment (the curves are all of 2,500 foot radius

View Looking South Across the "Big Fill," Which Will Be 2,500 Ft. Long with a Maximum Height of 75 Ft.



Route of the American Canyon Cut-off and Cross Section Plan for Terraced Cuts and Fills.

or over) easy grades and long sight distances, having no grade crossings with railroads, and making a saving of six miles over the present route, will prove a boon to the many motorists traversing this important state and interstate U. S. 40 road, amounting at peak periods to over 4,000 cars per day.

The work now underway consists, in the main, of grading and drainage structures. The volume of excavation amounting, as before stated, to 1,166,000 cu. yd., ranks this project as one of the largest ever handled in a single California state contract. Another large item is the overhaul of 14,000,000 station yards. The free haul is 300 ft.

The drainage structures, with one exception, consist of corrugated metal pipes ranging in diameter from 8 in. to 96 in., and have a combined length of 8,700 ft. The exception is a combined drainage structure and farm under pass, consisting of a timber trestle 209 ft. long and 34 ft. wide, having eleven 19-ft. spans. The bents are on concrete pedestals. This trestle comes in the middle of a large fill, having an estimated volume of 605,000 cu. yd. This fill is adjacent to and north of the "Big Cut" mentioned above and will be partly built from material from the "Big Cut" and partly from another cut just to the north, having an estimated excavation volume of 217,300 cu. yd. This fill has a maximum height of 70 ft. and is 2,500 ft. long. The "Big Cut" was planned to reach a depth of 130 ft. and is 2,400 ft. long.

Shovel Operation in the "Big Cut." The Cut Will Be 2,400 Ft. Long With a Maximum Depth of 130 Ft.

View Looking South from West Side of "Big Cut." Photo Taken March 22

Slides an Unexpected Development.—As the excavating on the project has progressed, we have been confronted with an unusual and entirely unexpected development of slides in several of the cuts.

The formation instead of being a stable, fairly hard rock (as we had reason to believe would be the case from the evidence of other cuts on highway work on each side of this area) proved to be largely of a decomposed shattered rock and soft shale, and in every case where soft blue shale has been encountered trouble with slides has developed.

This past winter has been unusually dry, and in none of the slides has there been any indication of water, apparently the nearly dry blue shale is sufficiently slick to allow the material to move on a very flat slope.

In the "Big Cut" the sides are breaking back, but so far the movement has not progressed a great way in proportion to the depth.

The most extensive slides so far is adjacent to a cut which at the time it developed was about 20 ft. deep. This slide started very suddenly, while the shovel was at work, with an abrupt raise in the floor of the cut of from 4 to 6 ft., and at the same time a moving forward of the side for a distance of about 10 ft. The remarkable feature was that this slide broke back nearly 500 ft. from the center of the roadway, and the natural slope of the hill is about a 20 per cent grade.

We are considering some changes in line and grade, to reduce the overrun in yardage, which is inevitable as these slides are removed. The line will be moved away from the side on which the slide occurs and the grade will be raised both in cuts and adjacent fills. Fortunately the work has not progressed so far that there will be any appreciable loss of finished section.

Some of the slides, we believe, can be handled by relieving the overburden by working off the top with heavy scrapers and bulldozers and then in some cases, by placing a bulkhead of piles and timber at the toe.

We are now prospecting through the large slide with soil augers, to find if possible the plane in which the

View Looking North from the "Big Fill." Fence in Right Background Outlines Slide at Station 393

Slide at Station 400. Note Offset in Cut and Raise in Bottom of Cut

earth is slipping. If after these data are obtained, it seems practicable, we will place numerous light loads of powder in this plane of slippage to break it up with the hope that it will then be rough and resist sliding.

The Plan for Terracing the Cuts.—Our original plan was for terracing the cuts (which we believe would have been sound in a reasonably stable material) and is as follows:

In the large cuts exceeding 30 ft. in depth we planned to open upon pioneer slopes of ½:1 before determining the first slopes to be used. If the bedding planes of the rock stratification were very nearly horizontal, the section would have a 1:1 slope extending for the entire length of the cut for the upper 30 ft. of cut depth; then a terrace and slopes of ¾:1 to ½:1 was planned, varying in approximately 30 ft. depths with a terrace between each change in slope.

If the strata were tipped the slope would be increased on the side which dips toward the roadbed, and decreased on the opposite side. We believe that this method of excavating in a stable material would result in fewer slides, in addition to providing a method of removing slides should they occur.

The terraces were planned, with the exception of the top one, to be 12 ft. in width, which is wide enough to walk a shovel to any point along the slope, which might break subsequent to excavation. The grades of the terraces along the roadway were planned approximately parallel with the existing ground, with a maximum grade of 15 per cent, and a 1:12 slope away from the roadway.

We believed that this terracing would help to prevent slope erosion by collecting the storm water at each lift and leading it to an outlet at the end of the cuts, would protect the traveling public by intercepting falling rock and would provide a method for taking out any local slides after the excavation is complete.

On the large fills we are having no trouble in staying with our original plans, and here these stepped slopes consist of a series of berms, 6 ft. wide at difference in elevation of about 25 ft., the fill side slopes to be 1½:1. This we believe will reduce slope erosion and give greater stability in the foundation of these deep fills.

The work to be done under the present contract will leave the grade 1½ ft. low in cuts and in sections where the soil is not too adverse. On the other portions, due to very adverse soil conditions, the grade will be left 2 ft. low. It is planned that under a future contract low shrinkage selected material will be placed over the entire section and the pavement placed on this.

The grading specifications provide that embankments of earth shall be constructed in layers not exceeding 8 in. in thickness, thoroughly rolled with a 12-ton, 3-wheeled roller or sheep-foot tamper, and watered if necessary to secure maximum compaction. Rock fills shall be constructed in layers not over 2 ft. thick, and thoroughly rolled by a 3-wheeled roller weighing not less than 12 tons.

Major Equipment Used on Job.—The contracting firm doing this work is Granfield, Farrar and Carlin, of San Francisco. They have the following major equipment on the job:

1 Diesel 1¾-yd. shovel.
1 Gas-air 1¼-yd. shovel.
1 Gas 1¼-yd. shovel.
1 Gas 1½-yd. shovel.
1 Gas 1¼-yd. dragline.
2 75-hp. tractor bulldozers.
3 60-hp. tractor bulldozers.
1 60-hp. tractor.
3 80-hp. tractors.
3 210 and 240 cu. H. compressors and 6 jackhammers.
1 Drill sharpener and furnace.
2 9-yd. scrapers.
1 7-yd. scraper.
2 3-ton scarifiers.
4 Tamping rollers.
1 Gas 3-wheel 12-ton roller.
1 Electric 10-hp. motor.
45 5, 5.5 and 7-yd. trucks.
1 12-ft. grader.
1 12-ft. Road patrol.

The superintendent in charge of the work for the contractor is John Carlin. The State is represented on the job by A. N. Lund, Resident Engineer. Earl Lee Kelly is Director of Public Works, C. H. Purcell, State Highway Engineer. The project is in District X, of which R. E. Pierce is District Engineer.

In order to make this section of road available for traffic, a subway is being built and 0.6 mile of roadway graded under a separate contract, at the Cordelia end of the change. It is hoped to get this important section completed and opened to traffic early in the next biennium, which begins July 1, 1935.

Progress on Highway Improvements Under Federal Public Works

Important facts concerning Federal appropriations for highways were given by Thomas H. MacDonald, Chief U. S. Bureau of Public Roads, in a hearing on Feb. 23 before the Committee on Roads of the House of Representatives on a bill to provide a new appropriation of $400,000,000 for emergency construction of public highways. In connection with this hearing, Mr. MacDonald presented a report he had submitted on Feb. 19 to the Secretary of Agriculture. This progress report covered the period of June, 1933, to February, 1934, and was submitted to the secretary for two purposes: "first, of presenting an accurate summary of the present status of the highway improvement projects authorized under Section 204 of Title 11, public works and construction projects, National Industrial Recovery Act, and second, of providing the basis of future Federal policies with respect to highway improvement." The report is reprinted herewith practically in full.

AS of Feb. 17 the Public Works highway program totaled 6,139 approved projects. That is, for this number of projects, the surveys, plans, and specifications have been prepared by the State highway departments, approved by the Bureau, funds allotted and all necessary details completed preparatory to the letting of the contracts.

The total estimated cost of the 6,139 approved projects is $312,939,000, of which $288,738,000 is to come from the $400,000,000 highway allotment, and the remainder, $24,201,000, is to come from other funds. The approved program is divided as follows:

2,508 projects on the Federal highway system—estimated cost....	$171,156,000
1,841 projects on extensions of the Federal-aid system into and through municipalities—estimated cost	71,241,000
1,790 projects on secondary roads—estimated cost	70,542,000

Contracts Awarded.—On Feb. 17, of the 6,139 projects of the approved programs, contracts have been awarded for 5,328. The total estimated cost of the contracts awarded is $275,905,000. Of this total estimated cost, $254,676,000 is from the Public Works allotment. In this list of 6,139 projects there are included 884 projects undertaken by direct labor.

All of these 5,328 projects are under construction except where weather conditions temporarily prohibit, or where contractors have not as yet had time to move on to the work.

Highway Projects Ready for Contract.—As of Feb. 17 there were 811 projects to cost a total of $37,034,000 being advertised for contract. Of this amount, $34,062,000 is from the Public Works highway allotment.

Highway Projects Completed.—Six hundred and fifty-one projects, costing a total of $17,222,000, have been completed. Of this amount, $16,188,000 was from the Public Works allotment.

Funds Available for Additional Highway Projects.—Seventy-three and three-tenths per cent of the total $400,000,000, less administrative reserve, apportioned to the states is now obligated to the 6,139 projects already approved. There remained as of Feb. 17, $105,262,000 available for additional projects.

The state highway departments have recommended programs which in total cover more than the available appropriation. These programs were for the most part prepared and submitted during July and August, prior to any reliable indication of the prices which would prevail under the changed conditions.

The prices during 1931 and 1932 were abnormally low and for the most part unreasonably below fair levels, yet there was no other basis on which to estimate the prices for the new program. Thus the programs recommended by the states will have to be modified to some extent as to the total amount of work possible to accomplish at present price levels. There has been a wide variation in the percentages of lift above the 1931-32 average price levels. These variations exist between the states and between the various classes of work. The average price difference between the present Public Works program and the 1932 average is, approximately 25 per cent. Only a part of this price increase is due to the special requirements of the rules and regulations issued to govern the highway projects such as the 30-hour week, the securing of labor from local lists, or to the considerably higher wage rates which are being paid on these projects.

Employment on Highway Projects.—Since the extensive Public Works program was undertaken primarily to provide employment, this report is designed to cover relationships of highway construction and employment rather than the matters of engineering technique or of transportation facilities.

The cumulative direct labor employment provided by the Public Works highway program is 2,500,000 man-months of continuous employment. Beginning with August the daily average employment directly on the work gradually increased until it provided for January, 132,000 continuous jobs.

Employment on Public Works highway projects will continue to rise rapidly until June when it will reach its approximate maximum of around 280,000 men continuously employed. By the first of September the major part of the work will have been completed and employment in this field will fall rapidly during the latter half of the year. The Public Works highway program will be completed as a major employment measure by the first of January.

In reporting employment on highway work the Bureau holds consistently to the reporting of continuous jobs offered and does not use the number of individuals appearing on the pay rolls. The fact does not seem to have been given sufficient attention that when labor is called for on a large number of construction projects, widely scattered, there is a much larger number of individuals participating in the employment than the exact number of continuous jobs provided, but the continuous jobs offered measure the continuous support of labor that is offered by this program.

Our records so far analyzed show a ratio of 1.8 individuals appearing on the pay rolls to each one reported continuously employed. That is, to provide continuous job employment for the 132,000 men reported for January, direct employment was provided for longer or shorter periods for 236,000 individuals.

In addition, there is the industrial and auxiliary employment off the job. The totals direct job and industrial employment indicate a ratio between these of approximately 1 to 1½. This ratio is a product of the existing limitations upon the hours per week and other conditions established by the regulations and by the various codes for employment both on and off the work. For other limitations or other types of work this ratio would probably change somewhat. This fact is pointed out because of fallacious arguments which have been advanced, based upon the ratio between employment and expenditures in other years when different limitations or no limitations existed.

This discussion is directed to the serious underestimating that exists of the total amount of employment offered by such construction as that included in the Public Works highway program. It does not pretend to represent the ratio between direct and industrial labor on any one particular project or any one class of work. Rather, it represents the generalized total result in amounts and kinds of employment offered by the very large program of highway construction made up of all the commonly used methods and materials.

In analyzing the employment offered by a mass construction program there are a number of phases of major importance. The first of these is the total amount of employment opportunity provided. Of this total the labor employed directly on the job is only a partial measure and should be used only as an index of the total jobs generated by such work. The best measure of the relation between highway construction and employment is the percentage of the dollar expended for highway construction that is redistributed to labor. The Bureau has repeatedly analyzed expenditures and has checked results against similar studies by other competent authorities. The conclusion that from 80 to 85 per cent of the road dollar is redistributed for employment is generally accepted as fairly representative. It is quite true that the division of this 80 to 85 per cent varies as to classes and types of employment with the variation in the type of construction; also as between labor employed directly on the job and supplementary labor, particularly of an industrial character, including labor engaged in transportation.

The second phase is that all useful construction work requires both materials and equipment. No works of permanent or durable character can result unless a considerable percentage of the expenditure is used for materials, including their transportation. In some phases of road work of the lower cost types the transportation is the major part of the cost of the materials. But the major item of manufacturing processes for the higher types of construction, as well as the manufacture and utilization of equipment, is the cost of labor and personal services. These facts all have a common foundation. There are practically no materials or even equipment that, traced to their source, begin with intrinsically valuable elements.

The third important phase of construction that utilizes materials and equipment is that employment in the production of these is offered in the normal fields of industry. Unquestionably one of the greatest national problems is to secure the return of as many of those now unemployed, or temporarily employed, to work that offers reasonable stability and that is normal to the individual. Such an objective necessarily accents the importance of the construction industry. While estimates differ as to the total of public and private construction reached in 1928, the peak year, there is little disagreement that the construction field, as a whole, has suffered the greatest loss of numbers employed. There is agreement that the ratio of the total amount of construction between 1928 and 1932 is roughly 5 to 1. It follows that the capacity of this field to offer employment therefore decreased between 1928 and 1932 about 80 per cent. A reasonable estimate is that for 5 men employed in 1928 only 1 was employed in 1932. This breakdown of the construction industry was a major manifestation of the depression. Progress toward recovery must inevitably mean the providing of greater employment in the construction field made up of both public and private activities. This is the firm foundation upon which the present Public Works program rests and its effect upon industrial recovery, including transportation, must be emphasized.

Authorities differ widely as to just what part of the total number of all those gainfully employed during the latter part of the last decade were directly and indirectly attached to the construction industry, but such figures as are available indicate that this part could not have been less than 20 per cent. There is a good deal of tangible evidence that at the peak of construction activity it reached—possibly slightly exceeded—25 per cent.[1]

The term "construction field" as used here covers not only the men who serve on construction work but those who prepare construction materials, who transport them or who in any other way render services which promote construction. This is the field in which unemployment has been and still remains the most serious, and therefore is the field in which the necessity for assistance at this time is the greatest.

At the present time approximately 130,000 continuous jobs are being provided on highway work for which funds are provided by section 204 of the National Industrial Recovery Act. At least 195,000 jobs are being provided in the production of materials for these highways, in transportation and in other lines which contribute to this construction. This is a current total of 325,000 jobs. In the recent past most of the men who now fill these jobs have been unemployed or at least under-employed. Their present employment indicates the effect of the highway program on the relief of unemployment in the construction field.

A consolidated statement of the job employment on all Federal and state highway work under direction of the Bureau and of the state highway departments for the month of January, 1934, shows a total of 315,989. This does not include work on streets under municipal authorities or on secondary roads under county or local authorities. This is probably the minimum figure for this year, and the summer peak as now estimated will reach 525,000. This schedule shows only direct job employment.

Future Program.—An extension of the Public Works

[1]Employment in the construction field has an important bearing on employment in the consumer goods and personal services field. Assuming that 75 per cent of those gainfully employed during the latter part of the last decade were producing goods and rendering personal services for the whole population, it follows that a quarter of the consumer goods market was in the construction field or that a quarter of those at work in the consumer goods and personal services fields—nearly 20 per cent (25 per cent of 75 per cent) of all of those who then were gainfully employed—were producing for those who were working in some capacity in the construction field.

With so large a fraction of all of the activity in the consumer goods field dependent on the buying capacity of the workers in the construction field, it is apparent that any change in activity in the volume of construction changes the demand on, and the activity in, the consumer goods field. The figures given above suggest that from 60 to 75 men in the consumer goods and personal services field must be affected for each 100 affected in the construction field.

highway program that will hold employment without a precipitous drop during the latter months of the year 1934 and through 1935, merging into employment for the year 1936 comparable with that existing in more normal times through the operations of the regular Federal-aid program plus the state-financed construction and maintenance program, will require an additional grant of around 375 millions now under the Public Works legislation, and provision for 125 millions under the Federal-aid legislation for the fiscal year 1936.

It is essential that employment opportunities of dimensions reasonably equal to those existing before the present emergency programs must be offered in the highway improvement and conservation field. This field offers a continuous opportunity for employment in the providing, perfecting and upkeep of facilities which are intimately related to the economic and social life of the whole Nation.

Since 1916 the Federal Government and the states have been engaged in a cooperative relationship which has extended to all of the states and every community in each state. There are two vital reasons why this relationship should be continued. One is the providing and maintaining of essential facilities. The other is the influence of the Federal Government in sustaining an extensive employment in this field as is consistent with continuously supportable expenditures.

Wage Rates.—The sections of title II, public works and construction projects, providing for the higway program, also specify in detail all of the major condition as to employment upon these projects. In accordance with these provisions of the law, the Secretary of Agriculture, with the approval of the Public Works Administration, issued detailed rules and regulations fixing the 30-hour week as a normal employment period. This weekly limitation is modified by the provision that any lost time occurring in 1 week may be made up if possible during succeeding weeks of the current month. Under this provision the average time on projects for the portion of pay rolls which have so far been analyzed indicates for the fall and early winter months a monthly average of 114 hours. The wage rates have been fixed in accordance with the law by the state highway departments for both skilled and unskilled labor.

Some confusion has existed over the term "skilled labor" which in the regulations provided is given a far different definition than as heretofore commonly used applying to the highest grade of journeymen-workmen. In the regulations the skilled worker begins with the driver of heavier trucks, and as applied to this particular class of work more nearly corresponds to experienced common labor. To avoid this confusion the Bureau has adopted the term "intermediate" or "semiskilled" labor as more correctly defining the grade for which minimum rates have been established by the state highway departments under the term "skilled labor."

Schedule 3 is an average rate summary for the pay rolls analyzed. Schedule 4 shows the rates by states established by the state highway departments and now in effect. Some modifications have been made from time to time, and there may be some individual items that are not now correct.

Miles and Types Included in Highway Projects.—On Feb. 1, 5,835 projects totaling 18,672 miles had been approved for construction, made up of all of the recognized highway types. Some conception is given to the extent of the highway construction program and the amount of employment offered, by the fact that this mileage is sufficient to extend six lines of double track highway from ocean to ocean or a single line of double track roadway three-fourths of the way around the globe. Two thousand seven hundred and forty-six bridges having a total length, with approaches, of 72 miles, are included in this work.

New Federal Highway Policies.—In the present program a number of new, as well as modifications of existing Federal highway policies, have been made effective.

Federal funds for municipal streets and secondary roads.—Of these, one of the most important is the use of Federal funds for the improvement of extensions of the Federal-aid system into and through municipalities without regard to size. A minimum of 25 per cent of the funds was required by the regulations to be allocated for this purpose, but as the program now stands this percentage has been increased voluntarily by the states to 28.78 per cent.

For the first time also Federal funds are being used for the improvement of secondary roads. As defined, this class comprises any roads not on the Federal-aid system. The regulations provide that not more than 25 per cent of the total funds should be used for this purpose and as the program now stands 24.07 per cent has been programmed to this class.

Grade crossing improvements.—Particular emphasis is placed in the law upon projects to eliminate highway safety hazards. For the first time the entire cost of the construction necessary to improve grade crossings is being paid from the Federal highway apportionments, but this does not include any land or property damages.

As an administrative policy, the principle has been made effective that the Federal highway funds should not be used to require involuntary contributions by the railroad companies. This decision was reached after consideration of the financial distress of the railroads as a whole and a recognition of the fact that if existing state laws were enforced in expenditures for this purpose there would be required in practically every state the contribution of a substantial part of the cost by the railroads.

The program now provides 206 grade separations, estimated to cost $8,608,514. Of these, 194 are railroad-highway grade separations. These separations are expected to cost $7,814,524. Twelve of these projects involve the separation of two intersecting highways. They will cost $793,990.

Footpaths.—One of the important causes of serious accidents and fatal accidents charged against highway traffic is the use by pedestrians of roadways designed for vehicular traffic only, particularly in the suburban districts of metropolitan areas. For the first time Federal funds are being used to provide footpaths and a reasonable start is being made in the furnishing of such facilities.

Roadside development and improvement.—There has been so widespread and insistent a demand for the extension of adequate improved roadways on which to operate motor vehicles that the practice has been general to confine the expenditures to this purpose and to design the roadways themselves without the comfortable margins desirable to contribute to safety and durability. While practice has required that the construction work be brought to a workmanlike finish, the conception of roadside improvement has heretofore stopped with the finishing and seeding of cut slopes and the careful cleaning up behind the construction operations. There is a widespread change in this attitude in the direction of roadside improvement by supplementary construction and planting. Proper landscaping is coming rapidly to be recognized as a necessary part of adequately improved highways.

To permit a widespread demonstration of the added values that may be secured through very moderate expenditure for roadside treatment, the policy has been in-

stituted of requiring in every State definite projects of roadside improvement as a part of the Public Works highway program. A minimum limitation of one-half of 1 per cent of the apportionment to each State has been set aside for this purpose. What is now a national demonstration will become very quickly an accepted national policy.

Advances to the States.—When this program was inaugurated a number of the State highway departments had been reduced to mere skeletons of an adequate organization. A considerable number lacked the funds sufficient to carry the personnel needed, and others, which had funds available for the engineering work on the Federal aid highways, lacked authority to make expenditures for the engineering necessary on municipal streets and secondary roads.

In order to overcome these obstacles where they existed an advance has been made on request of the State highway departments equal to about 5 per cent of the allotment to the State. This policy has made it possible for the States to finance their necessary operations and to meet their obligations promptly. All necessary safeguards, including the field auditing of all payments made from the advance fund and the covering of the deposits by ample security, have been made effective.

Future Planning of Highway Programs.—The experience in handling the present, as well as previous programs, has emphasized the necessity for broad planning on a national scale of the future highway improvement programs. This planning comprises two phases:

First, the division of the highways themselves into service classifications; and second, the surveys and other investigations of both an economic and an engineering character necessary to plan the specific improvements upon the systems as classified.

It will be recognized that the classification of highways is in a constant state of flux. There are the Federal aid system, the State highway systems, local roads, such as county and township, and also city streets. These classifications have been largely jurisdictional. There is needed continuation of studies now being carried on in some States and their institution in States where these studies do not now exist for the purpose of classification on the basis of present and future utilization. It is only by such a classification that we can build the long-time jurisdictional, financial, and engineering policies that are sound.

As to the second phase, the more important the improvement the longer the time necessary to make the detailed studies to insure a sound plan. Also, when public works are to be expended to absorb unemployment, it is necessary that these studies and plans be ready for such an emergency. It is recommended that the policy of future planning be recognized as a necessary continuous operation and that the authority be granted in any future Federal highway appropriations to use a reasonable percentage of the appropriation within the discretion of the Secretary for this purpose in cooperation with the State highway departments and with the National Planning Board.

There would be no change in the plan of procedure between the State highway departments and the Bureau in this future planning. It would be recognized as a project, or series of projects, the same as construction projects are now administered.

Federal Income from Highway Users.—Attention is called to the self-liquidating character of highway construction. The highway user is very heavily taxed. The Bureau has in final preparation a study of the returns through taxation of the road user by the Federal, State, and local authorities. The returns to the Federal Treasury during the calendar year 1933, as reported by the Bureau of Internal Revenue of taxes levied directly upon the road user and indirectly through sales taxes, totaled $257,217,517. At this rate the $400,000,000 set aside for highway construction will be returned from these sources to the Federal Treasury within the period that the funds are actually paid out.

Cooperation of United States Employment Service.—In the regulations established for the conduct of this work provision was made for the selection of the labor from lists prepared by the Reemployment Service of the United States Employment Service. This required the rapid establishment of a Nation-wide organization and the mobilization of the lists of workmen available for a very large number of the construction projects. The operations have been satisfactory and effective cooperation has existed.

The legal provisions governing skilled labor will have to be modified or administrative discretion provided to permit the Reemployment Service wide latitude in the selection of skilled labor to be used on highway projects. For unskilled labor the provisions of the law are satisfactory. There is every reason to believe that this plan of operation, if liberal direction is permitted to be exercised in the selection of skilled labor, establishes a practical and desirable policy.

Cooperation of State Highway Departments.—The fact that over 6,000 projects have been completely prepared and approved and contracts awarded for 90 per cent of these, is indicative of the response of the State Highway Departments to the tremendous demands of the Public Works highway program. The finest cooperation possible has been extended to the Bureau and to other Federal agencies by the State Highway Departments generally and there exists a splendid spirit toward the major objective of this program—the providing of employment on as extensive a scale as possible.

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New Edition of Bulletin on Mineral Identification

A new edition of United States Geological Survey Bulletin 679, "The microscopic determination of the nonopaque minerals," has just been published as Bulletin 848 and may be obtained from the Superintendent of Documents, Washington, D. C., for 20 ct. The previous edtion, which appeared in 1921, was the first reference work to place a systematic compilation of the optical properties of nonopaque minerals at the disposal of the sciences and industries dependent on accurate mineral determination. This work, based primarily on the indices of refraction, determined under the microscope, as the most fundamental diagnostic property of this group of minerals, made possible the wide application of the most accurate method yet devised for their identification. For this reason the earlier edition has been in constant use by mineralogists, mining geologists, ceramic engineers, and others throughout the world.

The new edition of 254 pages has been completely rewritten and the tables brought up to date by the introduction of about 500 new entries and 100 changes in old entries. About 250 new mineral species not given in the old edition are included, and tables have been added in which the data on the important mineral groups have been assembled. The new edition will therefore entirely supersede the earlier one and will be a necessary reference work for all those who have occasion to identify minerals.

The Origin and Composition of Igneous Rocks

By D. G. RUNNER

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IN this paper is presented the third of a series of discourses upon rocks and their manner of formation and composition. In two previous articles by the writer[1] the metamorphic and sedimentary types of rock were discussed. Since the science of geology and engineering is, and should be, intimately related it is highly important that the engineer know and be familiar with the more common and widely used rocks.

According to Clarke[2] the earth's crust to a depth of 10 miles is composed essentially of 93 per cent solid and 7 per cent liquid matter. Of this solid matter a very great portion is estimated to be of igneous origin. Based on the hypothesis of the above statement and the frequency with which the igneous rocks occur, it may be easily recognized that this group of rocks is likely to be encountered whenever construction of any kind is started. With this fact as a starting point, it is believed that the engineer should have some knowledge of the various igneous rock types, their manner of formation, and also their mineralogical composition. Texture, or the manner in which the mineral particles interlock with each other, also plays an important part in the study of rocks, and is a deciding factor in selecting materials for a definite purpose.

Rocks, which are composed chiefly of one mineral are spoken of as simple, but if they are composed essentially of several minerals, they are compound. Quartzite and marble are of the former class, while granite and basalt may be considered as examples of the latter class.

It is the purpose of this paper to discuss the origin and composition of the igneous type of rocks. As previously stated the sedimentary, or stratified rocks, and the metamorphic rocks have already been discussed. These two types might be referred to as secondary rocks, with the igneous rocks as primary. The reason for this will be brought out later in the paper. This article will be confined to the origin and manner of formation of the commonly known and widely used types of the igneous group such as granites, syenites, basalts (trap), etc. If more detailed and exhaustive information is desired, it is recommended that the standard texts be consulted. A selected list of literature, which should prove beneficial, is cited at the end of this article.

Areal Extent of the Igneous Rock in the U. S.—In the United States there are four regions where igneous rocks are quite common. With the exception of one locality, these regions are in the mountain belts, and geographically are: (1) New England, (2) Appalachian Mountain System, (3) North Central region, and (4) the Rocky Mountain System. According to various theories concerning the earth's origin, and the material of which it is composed, all parts of the original surface were derived from a magma (molten matter) stage. Hence the reason for the fact that igneous rocks are called primary, or first. The sedimentary type of rock was formed by the weathering of the existing primary rocks. Of necessity this type of rock is secondary because it is composed essentially of second-hand or derived materials. Later, both primary and secondary rocks were carried into the depths of the earth's crust and during this process, were changed in character by heat and/or pressure and became the third or metamorphic type of rock. In general, the igneous and associated rocks such as gneisses, form the backbone of the mountain systems.

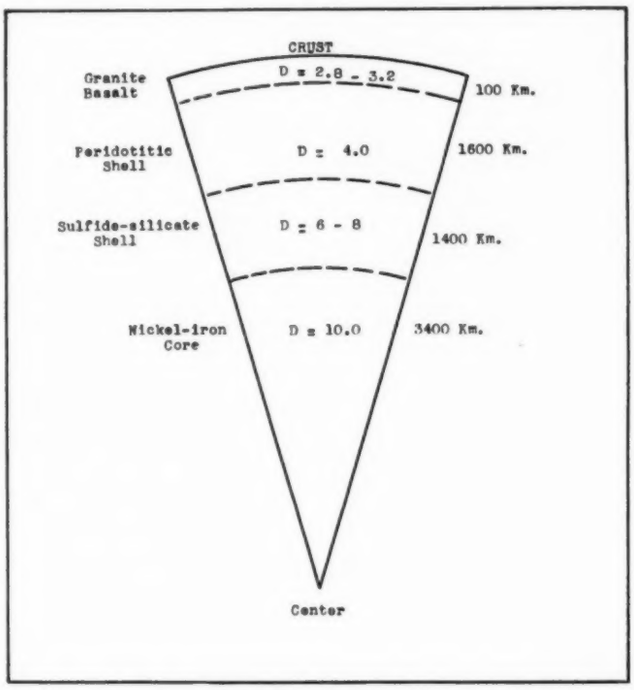

Fig. 1.—Theoretical Sections Through the Earth (Essentially After Williamson and Adams).

They are very resistant to atmospheric weathering and it takes eons of geologic time for them to become base leveled. In order to show the theoretical composition of the earth,[3] reference is made to Fig. 1, which is modified slightly from the original. In this figure it may be seen that the earth's crust is essentially silicic in composition with a density of 2.80 to 3.20. With increasing depth, the density becomes greater and greater until the mounting addition of nickel-iron causes the density to reach 10.00. In general, the magma forms the basement complex of the known continents, and the depths to which it may reach is not definitely known. The one good indication of its existence and composition, however, is in the lava flows from fissures, vents, and volcanoes in the earth's crust. Discussion of these lava flows will be taken up later on in the paper.

The Magma.—Igneous rocks are those which have congealed, or crystallized from molten magmas, the source of which is the interior of the earth. Rocks of this

[1]The Origin and Composition of Metamorphic Rocks, ROADS AND STREETS, vol. 76, No. 11, November, 1933.
The Origin and Composition of Sedimentary Rocks, ROADS AND STREETS, vol. 77, No. 2, February, 1934.

[2]Data of Geochemistry, by F. W. Clarke, Bulletin 770, U. S. Geological Survey, 1924.

[3]Williamson and Adams, Proceedings of Washington Academy of Science, vol. 13, pp. 413-28, 1923.

nature are known by their characteristic development of mineral associations, which have come about through definite chemical and physical laws incident to their crystallization. The fine-grained structure of igneous rock is indicative of rapid cooling, while the coarse-grained and fairly uniform distribution of the minerals throughout is the result of slow steady cooling of the molten magma. A magma is a silicate melt with additional sulphides, etc., together with water and gases. It is believed that all igneous rocks have differentiated from a limited number of magmas, possibly two; acidic and basic. The granite and basalts, which are found in more areas than all other igneous rocks combined, might be considered as respective examples of these two types of magma. The hypothesis that the original magma is confined to two kinds is based partly upon geological evidence and partly upon the physical chemistry of silicate melts.

Types of Igneous Bodies.—In relation to the overlying bodies of rock, the igneous material assumes, or is molded into different forms. These are chiefly: batholiths, stocks, sills, dikes and laccoliths. Reference is made to Fig. 2 in which these injected bodies are shown in relation to the surrounding country rock. The batholith is the largest igneous body known, and reaches to unknown depths. Most batholiths are found in orogenic regions or belts associated with mountain building. The Rocky Mountains are supposed to be made up of huge batholiths. Stocks are chiefly small batholiths, and are offshoots from the larger ones. Sometimes they may rise above the level of the main portion of the batholith or shoot off to one side depending upon the kind of adjoining rock bodies. Sills, or intrusive sheets, are the congealed bodies of magma found between the bedding or stratification planes of sedimentary rocks. Usually their lateral extent is much greater than their thickness. The Palisades of the Hudson River is typically a sill of about 70 miles in length with a thickness of between 400 and 900 ft. Dikes are merely the offshoots from the main body of magma, and should not be confused with the much larger stock. Laccoliths are usually dome-shaped masses of magma which have been intruded between stratified rocks. This laccolithic form is produced if the supply of magma from the source is greater than can be absorbed by the lateral movement. This condition causes the strata above to be uplifted to form an inverted bowl-like structure. The shape of igneous bodies is governed chiefly by the viscosity of the magma, the structure of

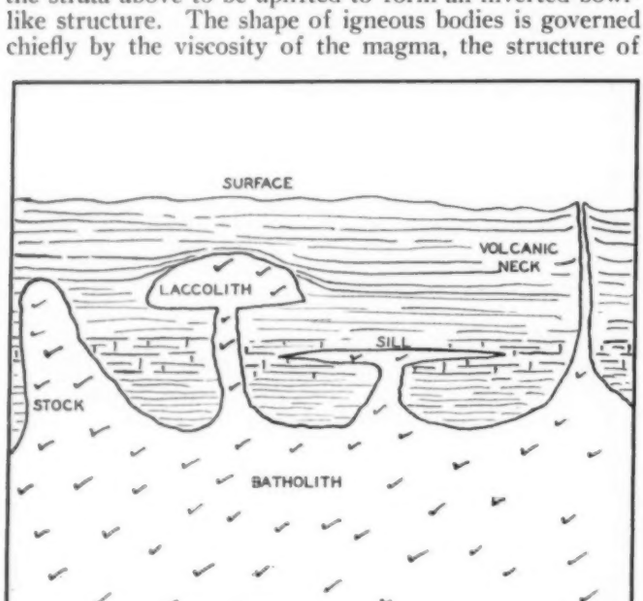

Fig. 2.—Diagram of the Various Forms of Igneous Rock.

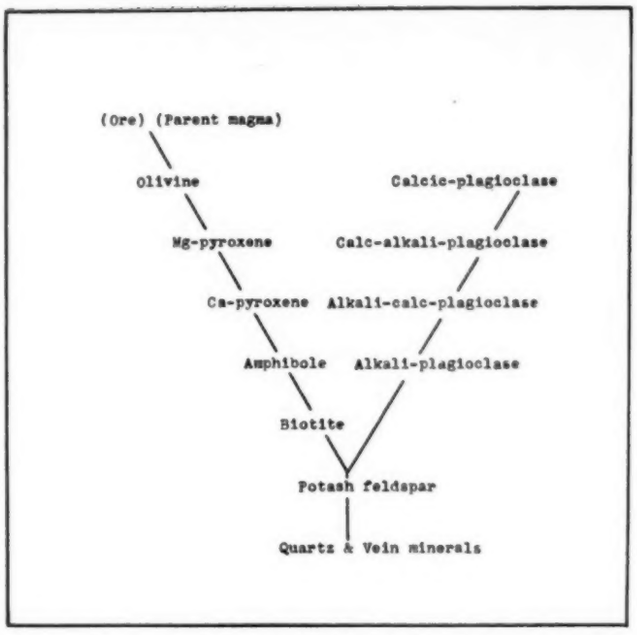

Fig. 3.—Diagram of the Reaction Relationship in Igneous Rocks (Modified After Tyrrell).

the surrounding country rock and the weight of the overburden. All of the above described forms apply to the deep-seated, or plutonic, type of igneous rock. The volcanic, or lava type, is of course merely the outpourings of magma from vents or fissures in the earth's crust. Upon contact with the air, the magma eventually cools and hardens into rock. With further reference to the topographic expression of the igneous bodies of rock, they are often more resistant to weathering than the surrounding rocks and consequently have a more pronounced relief. The central parts of mountain ranges consist of the batholithic rocks or cores. Laccolithic bodies may form groups of hills above the surrounding country side, while the smaller injected bodies, such as dikes and sills may be more or less resistant to erosion than the adjacent rock and consequently have little or no relief.

Order of Magma Crystallization.—According to their mode of origin, igneous rocks are divided into two main classes, namely: plutonic and volcanic. The plutonic type, of course, refers to those rocks which have solidified from magma before reaching the earth's surface. In fact, a large percentage never do reach the surface. The volcanic type refers to those rocks which have crystallized from magma issuing from vents or active volcanoes. Through long continued study and analyses of igneous rocks from all parts of the world, it has been calculated that they contain on the average, the following amounts of minerals:

	Per Cent
Feldspars	59.5
Hornblendes and pyroxenes	16.8
Quartz	12.0
Biotite	3.8
Titanium	1.5
Apatite	0.6

Although still under discussion it seems to be a general belief that all post-cambrian igneous rocks are derived from a basaltic "parent magma," and it has been found that the crystallization of the various minerals has taken place according to the so-called reaction principle. To discuss this phase would consume too much space, so that only a brief description will be attempted. The reaction principle is illustrated in Fig. 3. Starting with a "parent

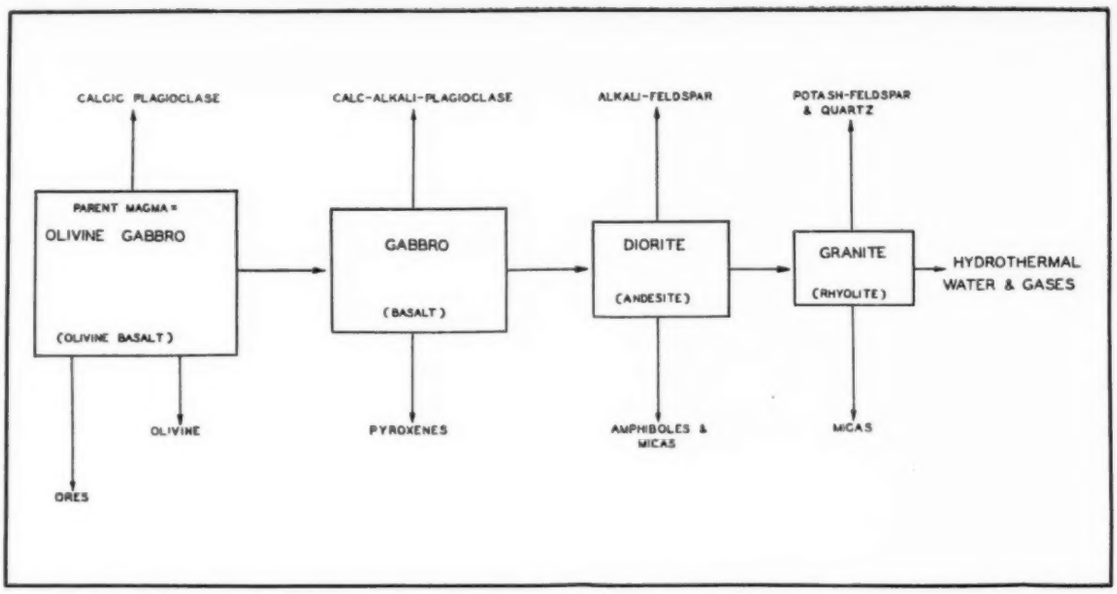

Fig. 4.—Genetic Relationship of the Igneous Rocks. Lava Rocks Shown in Parentheses.

magma," such as olivine gabbro, by physico-chemical laws, the ores congeal and settle out first. Next the olivines and calcic plagioclase feldspars emerge from the magma. The removal of these minerals changes the composition of the remaining magma to one less basic. However, the olivines and calcic plagioclase are magmatically "dead" and cannot be further changed. Next in order to congeal or freeze, are the magnesium pyroxenes and the calc-alkali-plagioclases, then the calcium pyroxenes and the alkali-calc-plagioclases emerge. And so on until the magma merges into potash feldspar. Finally there remains nothing but quartz and vein minerals which emerge as such. It should be understood that the above pairs of minerals congeal and settle out simultaneously from the magma. The genetic relationships of the minerals and rocks is shown in Fig. 4. The reaction principle is also shown in this figure and should be an aid in understanding this schematic diagram. The blocks in this figure represent the magma and illustrates the change which takes place when the magma changes from basic (represented by olivine gabbro) to the acidic stage (represented by granite). In short, this figure is descriptive of the entire history of igneous rock, from the primary or molten stage, until the rock is finally crystallized as such. It is realized that this discussion is brief, but space is limited, and the references quoted should be consulted for a more comprehensive study.

Texture of Igneous Rock.—Texture is an important feature of igneous rock inasmuch as it is indicative of the conditions under which the magma was congealed. The order of crystallization, rate of cooling, pressure and variations of physico-chemical laws are brought out in the textural modifications. Texture is an expression of the shape, size, and arrangement of the mineral constituents. Plutonic rock, which has solidified below the earth's surface, cooled slowly and thus permitted the even and full development of crystal structure. Volcanic rock, on the other hand, cooled so quickly that the minerals "froze" and consequently had little time for full development. In many instances the magma cooled so quickly that glass, lackng crystal structure entirely, was formed. The size of the crystals in igneous rock is one deciding factor in determining its life history.

A few textural terms, with which the engineer should be familiar, are: granular, porphyritic, and micrographic. There are a great number of terms used to describe all phases and conditions of texture, but the three mentioned above should suffice for all ordinary use. Granular texture is applicable to plutonic rock and implies that most of the mineral constituents are more or less of the same dimension. Granite is a typical example of granular texture. Porphyritic texture is applied to volcanic rocks and refers to developed crystals or grains imbedded in a dense ground mass of very fine minerals. This condition was probably caused by two different stages of congealing or crystallization. Micrographic texture is obtained when quartz and some other mineral crystallizes simultaneously to form an intergrowth. This feature produces a mottled appearance such as occurs in graphic granite. Figure 5 illustrates what is meant by granular, porphyritic, and micrographic textures.

Classification of Igneous Rock Plutonic Group.—According to the mode of origin, the igneous rocks may be classified under two large groups, the plutonic (deep-seated), and volcanic (lava type). Table I shows the main grouping subdivided into families. It should be kept in mind that there are a large number of igneous rock types. Some are common only in certain areas of the world. For example, the rock known as Vogesite is found in the Vosges Mountains and is probably known only in this vicinity. Another example is Wyomingite

TABLE I.—CLASSIFICATION OF IGNEOUS ROCK

MAGMA	
Plutonic Group (deep-seated)	**Volcanic Group (lava type)**
Granite	Rhyolite
Syenite	Trachyte
Diorite (1)	Andesite (1)
Gabbro (1)	Basalt)
Peridotite	Diabase)

(1) Also known as "trap"

Fig. 5.—Thin Sections of Rock Illustrating Various Textures (After Rinne).

which gets its family name from the State of Wyoming. Realizing that local names of rock type, based upon certain characteristics are confusing to the engineer, only those rocks listed under Table I will be discussed in this article.

Granites are plutonic rock, forming a large percentage of the earth's crust in the United States. They are usually even-grained, entirely crystalline and composed essentially of alkali-feldspars and quartz. Muscovite, biotite, and plagioclase feldspar are present in lesser amounts. Apatite, zircon, and magnetite are accessory minerals. Granites are generally medium to rather coarse-grained. Sometimes associated with granites are aplites, pegmatites, and greissen which differ from them in certain structural and mineralogical features. Figure 6 illustrates an exposure of granite. Note the system of joints caused by tension or compression as the magma cooled.

Syenites are deep-seated rocks characterized by the great amount of alkali-feldspar. The chief difference between granite and syenite lies in the amount of quartz present, with syenites containing little or no quartz. The texture is quite often coarse to medium-grained, with the minerals following the normal order of crystallization. Mineralogically the syenites consist of alkali-feldspars, with or without nepheline, some accessory quartz, hornblende, biotite mica and/or augite. Syenites are found only in small masses and quite often are local facies of a larger body of granite, or forms small plugs or dikes.

Diorites are deep-seated rocks, medium to coarse-grained, and consist essentially of plagioclase feldspar. Ferro-magnesian minerals such as hornblende and the micas are always present. The accessory minerals are quite often magnetite, apatite, and zircon in small amounts. By increase of the quartz content, the diorite becomes a grano-diorite, being closely akin to the granite family. Diorites are characteristically associated with mountain building and often occur as huge batholiths.

The *gabbro* family is second to granites in area throughout the world, and as in the case of diorites, are usually found in regions of mountain disturbances. Gabbros are usually medium to coarse-grained, and the chief mineral components are plagioclase feldspars and pyroxenes, with hornblende and magnetite as accessory minerals. The extreme basic types of gabbro are pyrozenite and peridotite. These rocks have little or no feldspar and generally contain augite, olivine, and/or hornblende. Some derivatives of the gabbroic family are norite, hyperite, and anorthosite. These rock types are found in extensive bodies in the Lake Superior region, the Adirondacks in New York, and in Quebec.

Peridotites are deep-seated and ultra-basic in composition, with the chief minerals consisting of olivine and augite and/or hornblende and biotite. The most common variety of the peridotite is dunite which contains about 90 to 100 per cent olivine. Peridotites are especially of interest due to the fact that diamonds, platinum and other rich minerals are often closely associated in these bodies.

Volcanic Group.—Rhyolite, which is the first rock of this classification, is the volcanic equivalent of granite. It has essentially the same chemical composition as a granite, and is thus predominantly silicic. The chief minerals are alkali-feldspar and quartz, with some small amounts of ferro-magnesian minerals. Rhyolites exhibit a variety of textural forms, sometimes being partly or even wholly glassy. The extreme glassy type is called obsidian. Rhyolite is found in the western part of the United States, in the Yellowstone Park, New Mexico, Colorado, and in California.

Trachytes are the volcanic equivalents of the syenite family, and typically consist of alkali feldspar, with a comparatively small amount of ferro-magnesian minerals, and no quartz. Of the feldspars common to trachyte, sanadine (a variety of alkali-feldspar) is probably the most predominant, and biotite of the dark minerals probably occurs more frequently than others. The texture of

Fig. 6.—An Outcropping of Granite. Note the Jointing Structure. (Photo by Dr. E. C. E. Lord.)

trachytes consists essentially of fine needles or plates of feldspar lying in parallel arrangement.

Andesites are the volcanic counterpart of the diorite family. They are intermediate in acidity and were so named because of their abundance in the Andes Mountains of South America. Mineralogically andesites consist of plagioclase feldspar and possibly one or more ferro-magnesian minerals, such as augite, hornblende, etc. The texture of andesites is essentially one of partly defined crystals in a glassy matrix.

The *basalt* group is the volcanic equivalent of the gabbroic family, and has practically the same chemical composition. The chief minerals in the basalts are calc-alkali-feldspar and pyroxenes. Basalts are generally limited to the fault zones and to the fissure type of eruption. In some areas deposits of basalt cover hundreds of thousands of square miles with an average thickness of one-half mile. Some fields in the United States where this type of rock is found are the Columbia and Snake River plains of Oregon. Basalts are also the chief product of the Hawaiian volcanoes. Diabase is usually classified with the basalt family. It is essentially a crystalline rock having a gabbroic composition and occurs chiefly in sills or as dike rocks.

Trap Rock.—Trap rock, according to the working classification of engineers and quarrymen, usually includes dark colored, heavy, igneous rocks composed essentially of ferro-magnesian minerals, basic feldspars, and little or no quartz. The family names of rock included under the general heading of trap are basalts, peridotites, diabases, fine-grained gabbros, hornblendites, and pyroxenites. However, the ordinary commercial variety of trap is basalt, diabase, or gabbro. With respect to mineral constitution, this feature has been discussed in the preceding paragraphs. It should be remembered though, that in trap rock, quartz fails to be an important constituent, and that the feldspars are usually plagioclase and not orthoclase. Furthermore it is next to impossible to properly identify the mineral constituents of trap rocks by the naked eye or even with a hand lens. Almost invariably a chemical or petrographic analysis, or both, is necessary to classify this variety of igneous rock.

Trap rock is found in large areas of Wisconsin, Michigan and Minnesota in the middle western region, and in the Connecticut Valley, Massachusetts, New York, New Jersey, and in Virginia in the eastern belt. Other parts of the United States may supply trap rock also, but it is believed that the states mentioned above furnish the greatest amount for commercial usage.

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Winter Experiments In Curing Concrete

COLD weather curing of portland cement concrete is not ordinarily a problem in California, but from time to time occasions arise where it is necessary to devise means for combating the effects of low temperatures on concrete construction. In the March issue of California Highways and Public Works Mr. C. S. Pope, Construction Engineer, State Division of Highway, describes the protective measures taken when such occasions have arisen. He also describes a series of tests made in 1933. The notes following are taken from his article.

During the winter months of 1929, 1931 and 1932, sufficiently cold weather prevailed to make necessary the protective measures described below.

On a paving project in San Diego County in 1929, temperatures as low as 18° F. were successfully combated by the use of a blanket of dry earth 3 in. thick on the pavement, to which was added a covering of 3-ply burlap. By this means the curing temperature was maintained at above 50° F.

Bituminous Membrane Used.—On paving in the Sacramento Valley during 1932, a different method of procedure was used. Curing was done by the use of bituminous membrane covering with the following additions:

The temperature forecast for the next 24 hours was obtained from the local weather bureau about 4 p. m. If the forecast indicated a minimum temperature above 32° F., a single layer of burlap was used on the current day's run and bituminous curing membrane was applied the following morning. If temperatures below 32° F. were indicated, the current day's run was covered with double burlap and a bituminous membrane applied next day.

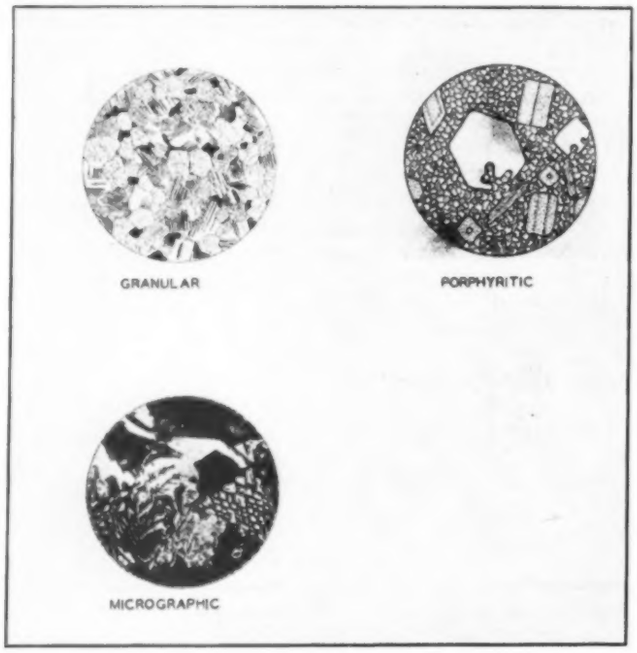
If the cold weather continued, a single layer of burlap was applied for the next two nights; if the temperature under the burlap was quite low, double burlap was used for three days. The above practice was acceptable only when temperatures of 32° F. or less did not exceed a 4-hour period; for such longer cold periods, the provisions of the Standard Specifications prevailed.

Winter Paving on Ridge.—Certain experimental work in curing methods was done at Castaic on concrete paving, but was not conclusive because weather temperatures were not very low and protective measures were somewhat insufficient.

Paving was started on the Ridge Route Alternate on Feb. 14, 1933, and the bituminous membrane method of curing was used. From one to 3-ply layers of burlap were used during cold weather to protect the concrete, and beam breaks were used to determine the proper time before pavement opening, the beams being subjected to the same temperature, etc., as the pavement itself. No concrete was laid on frozen subgrade, and in general the provisions of the Standard Specifications relative to cold weather concreting were complied with.

The strength of concrete obtained under the above curing methods was checked by beam breaks and proved satisfactory.

The Experimental Tests.—In view of the fact that information as to the above tests had not been recorded with any great care nor generally disseminated, a more ambitious investigation was undertaken early in 1933 in which the State Division of Highways Materials and Research Laboratory and the Construction Department of the Division collaborated.



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Winter Experiments In Curing Concrete

COLD weather curing of portland cement concrete is not ordinarily a problem in California, but from time to time occasions arise where it is necessary to devise means for combating the effects of low temperatures on concrete construction. In the March issue of California Highways and Public Works Mr. C. S. Pope, Construction Engineer, State Division of Highway, describes the protective measures taken when such occasions have arisen. He also describes a series of tests made in 1933. The notes following are taken from his article.

During the winter months of 1929, 1931 and 1932, sufficiently cold weather prevailed to make necessary the protective measures described below.

On a paving project in San Diego County in 1929, temperatures as low as 18° F. were successfully combated by the use of a blanket of dry earth 3 in. thick on the pavement, to which was added a covering of 3-ply burlap. By this means the curing temperature was maintained at above 50° F.

Bituminous Membrane Used.—On paving in the Sacramento Valley during 1932, a different method of procedure was used. Curing was done by the use of bituminous membrane covering with the following additions:

The temperature forecast for the next 24 hours was obtained from the local weather bureau about 4 p. m. If the forecast indicated a minimum temperature above 32° F., a single layer of burlap was used on the current day's run and bituminous curing membrane was applied the following morning. If temperatures below 32° F. were indicated, the current day's run was covered with double burlap and a bituminous membrane applied next day.

If the cold weather continued, a single layer of burlap was applied for the next two nights; if the temperature under the burlap was quite low, double burlap was used for three days. The above practice was acceptable only when temperatures of 32° F. or less did not exceed a 4-hour period; for such longer cold periods, the provisions of the Standard Specifications prevailed.

Winter Paving on Ridge.—Certain experimental work in curing methods was done at Castaic on concrete paving, but was not conclusive because weather temperatures were not very low and protective measures were somewhat insufficient.

Paving was started on the Ridge Route Alternate on Feb. 14, 1933, and the bituminous membrane method of curing was used. From one to 3-ply layers of burlap were used during cold weather to protect the concrete, and beam breaks were used to determine the proper time before pavement opening, the beams being subjected to the same temperature, etc., as the pavement itself. No concrete was laid on frozen subgrade, and in general the provisions of the Standard Specifications relative to cold weather concreting were complied with.

The strength of concrete obtained under the above curing methods was checked by beam breaks and proved satisfactory.

The Experimental Tests.—In view of the fact that information as to the above tests had not been recorded with any great care nor generally disseminated, a more ambitious investigation was undertaken early in 1933 in which the State Division of Highways Materials and Research Laboratory and the Construction Department of the Division collaborated.

W. H. Mohr represented the laboratory and prepared the report from which the data quoted are taken, while F. A. Read acted as observer for the construction department, the work being under the general supervision of District Engineer S. V. Cortelyou.

The site of the experiment was the Ridge Route Alternate in Los Angeles County. Experimental test sections were constructed at Chandlers during February, 1933. These test sections contained 80 cu. ft. of concrete and were made up of two slabs each 4 ft. by 20 ft. by 6 in., each slab containing seven divisions 4 ft. by 2 ft. 10 in., a total of 14 test sections. Each section was cured under different conditions and observed hourly over a 5-day period. The concrete materials used were the same as those in the proposed Ridge Route pavement; water came from Chandlers and was not heated.

Thermocouples in Cement.—Electro-thermocouples of copper and constantan wire were placed in 13 of the sections and 14th was left exposed in an uncured condition. The ends of the thermocouples were buried about ¼ in. in the concrete and a Leeds and Northrup Potentiometer was used to measure the potential of the thermocouples, the readings being converted into degrees of temperature. Three inch mercury thermometers were used to measure the internal temperature of the concrete, being imbedded about 2¼ in. in oil wells. The relative humidity was recorded by the use of a sling phychrometer.

Hourly observations of weather, wind, air temperature and humidity were made over a 5-day period immediately following the pour of the slabs.

The lowest temperature recorded was 19° F. at 6 a. m. and the highest temperature was 62° F. Had the same temperature range persisted over the 35-day curing period which elapsed before cores were tested, the heat-hours at the time of test would have approximated 30,000 units.

Variations of Covering.—The coverings used to protect the concrete were as follows:

1. Hopcloth, wet.
2. Burlap, 12-ounces, 1 layer, wet.
3. Burlap, two layers, wet.
4. No cure, dry.
5. Earth blanket, 2-in., wet
6. Earth blanket, 4-in., wet.
7. Ponding. wet.
8. Bituminous membrane on surface and subgrade, dry.
9. Bituminous membrane, dry.
10. Bituminous membrone, 1-in., earth blanket, dry.
11. Bituminous membrane, plus 1 layer burlap, wet.
12. Impervious paper, Type A, dry.
13. Impervious paper, Type B, dry.

Tests of covering 1 and 3 were made on 7-sack concrete.

Three cores from all specimens were taken for crushing at 35 days.

Test Observations.—Core strengths at 35 days show the following results listed in the order of breaking strengths.

Method of Curing	Compressive strength lb./sq. in.	Per cent
* 1. Hopcloth	4,243	106
8. Bituminous membrane on surface and subgrade	3,990	100
* 2. Burlap, 12-ounce, 1 layer	3,950	99
6. Earth blanket, 4-inch	3,845	97
9. Bituminous membrane	3,773	95
10. Bituminous membrane, plus 1-inch earth	3,492	88
5. Earth blanket, 2-inch	3,453	87
11. Bituminous membrane, plus 1 layer burlap	3,400	85
7. Ponding	3,286	82
12. Impervious paper, Type A	3,165	79
3. Burlap, 2 layers	3,050	76
13. Impervious paper, Type B	2,977	75
4. No cure	2,351	59

Tests marked thus * are 7-sack concrete.

Bridge Department Methods.—The problem facing the bridge department in cold weather curing is somewhat more difficult than the ordinary problem of protecting a paving slab, and the following description is therefore of interest:

Four bridges were constructed on the Ridge Route Alternate during the winter of 1932-33, prior to the construction of the thirty-foot pavement on this new route. At an elevation of 4,000 ft. on the old route, winter blizzards occurred during which automobile traffic was stalled in heavy snows having a maximum depth of 5 ft.; on the new route, however, less than 2 ft. of snow fell.

The bridges were steel deck plate girder spans on reinforced concrete piers and abutments, the piers varying from 39 to 67 ft. in height, thus offering considerable surface exposure to cold weather.

Heat Provided by Fires.—Heavy forms were used consisting of 2-in. T & G lumber built barrel stave fashion for each pier; concrete was poured in two days and forms removed the following day.

Mixing water heated by passing pipes through wood fires, raising the temperature to about 150° F. and the concrete in the forms to about 65° F., thus insuring proper chemical action in the setting of cement. Additional protection for curing was required, and tarpaulins hung on bracing scaffolds enclosed each pier. Heat was supplied by coke salamanders under the tarpaulins and thermometers were used to record the curing temperature. Heating was continued until the concrete developed about one-fourth of the required 28-day breaking strength.

For the concrete decks, curing methods developed on the adjacent paving project were used. A bituminous membrane was applied, covered with burlap, thus protecting the surface against evaporation and temperature drop. It was believed that the black bituminous membrane absorbed more heat from the sun's rays during the day than plain concrete, and the burlap helped prevent radiation of this heat during the night.

This method of curing was found satisfactory with night temperatures as low as 20° F., during clear weather. Due to the exposed decks, the tarpaulins were allowed to hang over the edges, while the heating below by salamanders was continued until proper strength was developed as for the piers.

Conclusions Reached as Result of Tests.—Unsatisfactory concrete will result under any method of curing tried in the above tests where concrete is placed in locations where the temperatures fall below 20° F. at any time.

Black curing membranes increase the heat absorbed by the concrete during the daylight hours, and where covered at night with an insulating medium such as dry burlap or dry earth, the heat is retained in the concrete and thus increases its strength.

Ponding or curing with wet burlap prevents the sun's rays from warming the concrete and induces evaporation which lowers the temperature and delays proper curing.

Recommendations Made.—It is recommended that no concrete work should be planned for conditions where temperatures will go below 32° F. during the curing period. Under emergency conditions, means should be taken to insure heating the aggregates and the maintenance of sufficient warmth in the concrete during the first five days after laying to secure adequate curing. A usual method is to cover the concrete paving with impervious paper or canvas stretched over frames at a sufficient height to allow lanterns or other heating units to be placed under the blanket.

Code of Fair Competition for the Construction Industry

Chapter II—General Contractors' Division*

Approved on February 17, 1934, by President Roosevelt
Effective on March 19, 1934

Article I.—Definitions.

Section 1.—A General Contractor.

THE term "general contractor" is hereby defined to mean without limitation any individual, partnership, association. trust, trustee, trustee in bankruptcy, receiver, corporation or agency which undertakes, whether by formal contract or otherwise, to direct, superintend, coordinate and execute, either directly or through others, the work of constructing, substantially in its entirety, any fixed structural or physical improvement, or a modification thereof, or an addition or repair thereto, excluding any such operation aggregating in its entirety less than the sum of $1,000.00.

It is recognized that the function of the architect or professional engineer is to design or plan construction projects and acting in his professional capacity, to supervise the execution thereof on behalf of the owner. Such architects or professional engineers in the performance of their normal and customary functions shall not be deemed to be included in the foregoing definition of a general contractor.

Section 2.—Subdivision.†

The term "Subdivision of the General Contractors Division of the Industry," or "subdivision" shall mean a defined section of this division, established for administration purposes. Without limitation upon any additional subdivisions, the subdivisions which shall be established and defined in Sub-Chapters II A, II B and II C hereto are:

Chapter II A.—Building Contractors Subdivision.

Chapter II B.—Heavy Construction and Railroad Contractors Subdivision.

Chapter II C.—Highway Contractors Subdivision.

The subdivisions under this chapter may in their respective subchapters amplify and expand the provisions of this Code, and the same, when approved by the Administrator, shall apply to the respective subdivisions so proposing the same, with the same force and effect as any other provisions of this Code.

Section 3.—Association.

The term "Association" as used herein shall mean The Associated General Contractors of America.

Section 4.—Sub-contractor.

The term "sub-contractor" as used herein shall mean any one other than an employee who enters into a contract for the performance of an act with the General Contractor who has already contracted or otherwise arranged for its performance.

Article II.—Administration.

To further effectuate the policies of the Act and to administer this Code within the General Contractors Division and its subdivisions there shall be established a Divisional Code Authority for General Contractors as provided herein.

A. DIVISIONAL CODE AUTHORITY.

Section 1.—Constituency.

The Divisional-Code Authority for General Contractors intended to be referred to as "The Divisional Code Authority," shall be composed of seventeen (17) members, twelve (12) of whom shall be appointed annually by the Executive Committee of the Association from its Board of Governors and/or its Advisory Board, and each member so appointed shall serve until the new annual Executive Committee of the Association shall reappoint him or appoint his successor. The twelve (12) members so appointed shall appoint to the Divisional Code Authority five (5) additional persons to be approved by the Administrator engaged in the business of general contracting, who are not at the time of selection representative of or responsible to members of the Association and each of the five (5) members so appointed shall serve until he is so reappointed or his successor selected, or until he or his successor shall be selected by the non-members of the Association pursuant to a method of selection satisfactory to and approved by the Administrator.

Section 2.—Powers and Duties.

The Divisional Code Authority shall have, in addition to the powers and duties conferred upon it by Chapter I thereof, the following powers and duties applicable to the General Contractors Division.

(*a*) Its members or its authorized representatives may upon request attend meetings of any administrative agency established for any subdivision.

(*b*) It is authorized under the supervision of and in cooperation with the Construction Code Authority in the exercise of the power conferred upon it in Section 2 (*d*) of Article IV A of Chapter I to require the registration in such manner as it may deem appropriate of all construction work undertaken by general contractors as herein defined exceeding two thousand dollars ($2,000.00) in value, and, in order to defray the expenses of such registration, of the collection of the reports and the data herein required and of the administration of this code, to charge and collect as a registration fee not to exceed one-tenth of one per cent of the value of the work. From the funds so collected. The Divisional Code Authority shall defray its expenses and the general contractors' proportionate share of the expenses of the Construction Code Authority, in administering this Code, and make an equitable apportionment between the Divisional Code Authority and the subdivisional committees or agencies as shall cooperate in procuring the registration of such work or services.

B. SUBDIVISIONAL ADMINISTRATIVE COMMITTEES OR AGENCIES

Section 1.—Procedure for Establishing.

There shall be established for each subdivision of the General Contractors Division an Administrative Committee or Agency which shall, within the limitations provided herein, administer within such subdivision the provisions of this Code applicable specifically to such subdivision. The procedure for establishing each such administrative committee or agency shall be defined in the sub-chapter pertaining to that subdivision of the General Contractors Division.

Section 2.—Powers and Duties.

Each such subdivisional administrative committee or agency shall have in addition to such duties and powers as the Divisional Code Authority may delegate, the following powers and duties:

(*a*) It may establish rules and regulations for the conduct of its affairs and may appoint such committees, agencies and representatives and delegate to them such of its powers and duties as it may deem necessary for the proper discharge of its functions hereunder.

(*b*) It shall cooperate with the Divisional Code Authority in making investigations as to the functioning and observance of this Code within its subdivision at its own instance or on complaint of any person affected, and shall collect from members of the

*Must be observed in conjunction with Chapter I—General Provisions of the Code of Fair Competition. Chapter I was printed in the March issue of ROADS AND STREETS.

†Captions to Articles and Sections, where omitted in the official draft have been added by the Construction League to assist the reader.

subdivision and compile and furnish to the Divisional Code Authority, any reports and other information required under the Act.

(*c*) It shall study the trade practice provisions applicable to its own subdivision, and the operation thereof, and may make such recommendations to the Divisional Code Authority as it deems desirable for modification or addition thereto. Such recommendations, upon approval of the Administrator after such notice and hearing as he may prescribe, shall become a part of this Code and have full force and effect as provisions hereof.

(*d*) It shall receive and so far as possible adjust all complaints as to trade practices between members of its subdivision in the operation of the provisions of this Code applicable to that subdivision.

(*e*) It may prescribe bidding rules, requiring the inclusion in each bid of all direct and indirect costs properly defined, and methods for administering such rules, and such rules and methods, when approved by the Administrator, shall apply to the members of its subdivision.

Article III.—Appeals.

Section 1.—Local Adjustment.

Controversies or complaints within any subdivisions shall be fully determined and adjusted locally so far as practicable, otherwise by the administrative committee or agency established for such subdivision.

Section 2.—Appeal to Divisional Authority.

Any party directly affected shall have the right to appeal to the Divisional Code Authority and of a prompt hearing and decision, under such rules of procedure and proper charges to cover costs of investigation and hearing as it may prescribe, in respect of any decision, rule, regulation, order or finding made by any subdivisional administrative committee or agency.

Section 3.—Power of Authority.

The Divisional Code Authority shall have original jurisdiction of all controversies affecting more than one subdivision of General Contractors.

Article IV.—Practices as to Submitting Bids.

Section 1.—Bids by General Contractors.

In order that whenever contracts are to be let by competitive bidding the terms of the competition shall be such as to insure fair competition, a general contractor, in submitting bids for the construction or improvement of either private or public works, shall be governed by the following provisions:

(*a*) All bids shall be in writing, signed by an authorized representative of the bidder. Alternate proposals may be submitted with the original bid, providing the same privilege is extended to all bidders.

(*b*) A general contractor shall not take advantage in his bid of any special privilege, favor or understanding had with him by persons in control of the award. This, however, shall not prevent any such competitor, even though not the lowest bidder, from taking such contract, providing the award is made at his original competitive price, nor shall it prevent any contractor from accepting the award of such contract at any price where no competitive bids are taken.

(*c*) A general contractor shall not revise his bid after bids have been opened in order to improve his position with the owner. Bona fide mistakes discovered after the opening of bids shall be grounds for withdrawal only.

Where supplemental bids are requested because of substantial changes in the plans and/or specifications, such bids shall reflect only the true value of the changes.

A general contractor shall not bid upon a private construction project upon which bids have been opened, or at any time within 90 days next thereafter, except there be substantial changes in the plans and specifications.

(*d*) Standards of accounting, cost keeping and estimating may be prescribed by subdivisions for the purpose of determining a fair price for services or products and systems for the interchange of such information subsequent to the award of specific work may be established. Such standards shall be subject to the approval of the Divisional Code Authority and of the Administrator.

Article V.—General.

TRADE PRACTICES

Section 1.—Qualification of Contractor.

A general contractor bidding upon or undertaking to execute construction contracts shall be properly qualified by capital, organization and experience. He shall own or have available sufficient and proper equipment to execute the work bid upon or furnish evidence of his ability to acquire same.

Section 2.—Credit Information.

A general contractor shall make available upon request to those responsible for the award of construction contracts, pertinent information as to his current financial position, using the standard questionnaire forms developed and approved by and available through the Joint Conference on Construction Practices, Washington, D. C., or other forms approved or prescribed by the Administrator, and may request equivalent information from the owner.

Section 3.—Records and Accounts.

A general contractor shall maintain and employ an adequate system of records and accounts, which system shall clearly show the allocation as to each specific project of all funds received or disbursed on account thereof.

Section 4.—Contractual Agreements.

The following bases of contractual agreements are recognized as fair trade practices; guaranteed price, cost of the work plus a fee, unit price, lump sum, and other contractual methods not inimical to the public interest, providing that the regulations contained in this Code of Fair Competition are met.

Section 5.—Prohibited Agreements.

A general contractor shall not enter into any agreement or understanding prior to the award of a contract where such award is made as a result of competitive bidding by which agreement or understanding he agrees to accept a lesser amount for his services than the amount stated in his bid.

Section 6.—Disputes.

A general contractor shall be ready and willing to settle disputed matters promptly. Where arbitration as a method of settling disputed matters is agreed upon, the rules of procedure as established by the American Arbitration Association shall govern, except as otherwise required by law or contract. Payment, exceeding that sufficient to cover the amount in dispute, shall not be withheld from the parties affected.

Section 7.—Payments by General Contractor

Funds received by a general contractor for construction work performed or to be performed by him shall be accepted and applied first for the purpose of paying amounts due from him to others in respect of any portion of such work including amounts due to employees, material men, sub-contractors and others. These provisions shall not be construed to require a general contractor to keep in separate bank accounts or deposits the funds received under separate contracts, provided that he shall maintain books of accounts which shall clearly show the allocation to each and every contract of the funds deposited in his general or special bank account or accounts, and he shall devote the final payments to him from the owner within ten days after the receipt thereof, to the payment of the balances due from him to such employees, material men, sub-contractors and others, provided satisfactory evidence is furnished showing that all outstanding claims against such parties, for which the general contractor would otherwise be liable, have been fully satisfied or provided for. Earlier payments and/or greater amounts may be mutually agreed upon.

Nothing in this section shall supersede any Federal, State or local laws imposing more stringent requirements with respect to matters referred to herein.

Section 8.—Rebates.

A general contractor shall not give or accept rebates, refunds, allowances, unearned discounts or special services to or from sub-contractors, material vendors or others which are not extended under like terms and conditions to or by other sub-contractors, material vendors and others of equal credit rating.

Section 9.—Financing.

A general contractor shall not permit or require sub-contractors or material vendors to finance his accounts unless such arrangement is expressly provided for in the original contract between the parties.

Section 10.—Waiver of Legal Rights.

A general contractor shall promptly inform sub-contractors with whom he is contracting of any waiver of lien rights executed by the general contractor.

Section 11.—Deficient Plans.

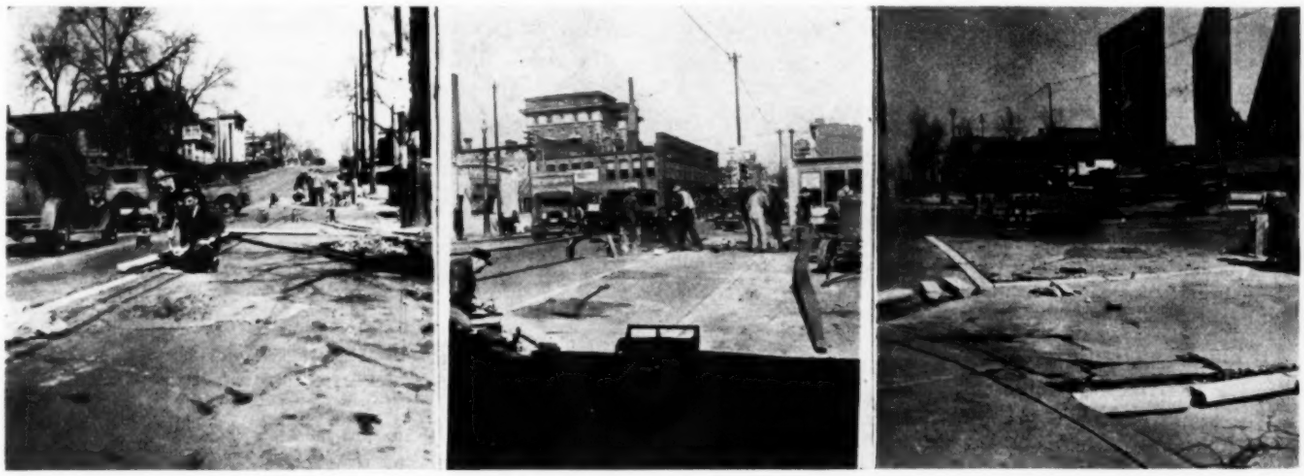
In competitive bidding a general contractor shall not offer or agree to assume the responsibility for deficiencies in or omissions from the plans and/or specifications, which he has not prepared or caused to be prepared by others, and upon which the contract is based, for the purpose or with the effect of securing an unfair competitive advantage.

Installs Concrete Block Traffic Markers at Street Intersections

Omaha, Nebraska, has found a solution to the problem of maintaining traffic lane markers on old brick and asphalt streets. The solution has also helped in the Omaha relief problem, since work has been carried on throughout the winter making and installing the new markers.

The new marker is a precast concrete block 6 in. wide, 4 in. deep and 24 in. long. The top surface of these is made of white cement, ¾ in. thick. These are set in the old pavement to form a continuous 6-in. line, marking safety zones for street cars and pedestrian traffic lanes at all street intersections.

Marker blocks are cast in gang molds on city property.



Installing Precast Concrete Blocks as Traffic Lane Markers in Old Pavements at Omaha, Neb.

Section 12.—Labor Welfare.

A general contractor shall provide for the welfare and safety of his workmen, complying with all applicable laws governing such matters. Except where such laws otherwise require, he shall comply with the provisions of the safety manual heretofore adopted by the Associated General Contractors of America.

Section 13.—No Prison Labor.

A general contractor shall not employ prison labor in the execution of the work.

Section 14.—Payment of Wages.

A general contractor shall as promptly as possible make payment of all wages due, in lawful currency of the United States, or by a negotiable check at par therefor payable on demand. A general contractor or his agents shall accept no rebates directly or indirectly on such wages, nor give anything of value or extend favors to any person for the purpose of influencing rates of wages or the working conditions of his employees.

Article VI.—Reference to Provisions of Chapter I.

The mandatory provisions required by the Act, and all other provisions contained in Chapter I of this Code (approved January 31, 1934), except as otherwise provided in this Chapter II, apply with like force and effect within this division of the Construction Industry, as if incorporated herein.

Article VII.—Modification.

Subject to the provisions of Section 2, (*c*) of Article IV, B, of Chapter I of this Code, the provisions of this chapter, except as to provisions required by the Act, may be modified on the basis of experience or changes in circumstances, such modifications to be based upon application to the Administrator and such notice and hearing as he shall specify, (30th) day after its approval.

Article VIII.—Effective Date.

This chapter shall become effective on the thirtieth (30th) day after its approval by the President.

After casting they are moist cured for ten days—then air cured until 28 days old. Then the blocks are set in trenches cut to the base, through the surface. When necessary the concrete base is chipped away with an air chisel.

After the marker is set in place high early strength mortar is used to embed the marker. Traffic is opened within 24 hours. A total of 240,000 lin. feet of markers is included in the project.

▼

Seventh International Road Congress

In connection with the 7th International Road Congress to be held this year in Munich, Germany, a special exhibition of road building will be held at the same time. The exhbition is to consist of a general section "The Road," showing the character of the highway and road traffic, the possibilities of its development, and an industrial section, which embraces road building machinery, the domain of prepared and raw materials, their preparation, and exhibits of different methods of construction.

The General Section of this exhibition will probably be held from June 15 to Sept. 3, 1934, at the Munich Municipal Exhibition Grounds, while the Industrial Section will be shown from Sept. 3 to Sept. 14, 1934, on the same grounds, but in other halls.

The exhibition is organized by the "Verein Strassenban-Ausstellung Muenchen 1934, 55 Briennerstrasse, Munich, Bavaria, Germany," to which all enquiries regarding space are to be addressed. The area to be occupied by the Industrial Section is 10,000 square meters, of which 7,200 square meters have been reserved by the German Industry.

Code of Fair Competition for the Construction Industry

Proposed Code for Chapter II-C—Highway Contractors' Sub-Division of General Contractors' Division*

PURPOSES

TO effectuate the policies of Title I of the National Industrial Recovery Act, the following provisions are established as Chapter II-C, Highway Contractors Sub-Division of the General Contractors' Division of the Construction Industry, and shall be the standard of fair competition for Highway Contractors, as defined herein.

Article I.—Application.

The mandatory provisions required by the Act and all other provisions contained in Chapter I of this Code (approved Jan. 31, 1934), and of Chapter II (approved Feb. 17, 1934), except as otherwise provided in this Chapter II-C, apply with like force and effect to this Chapter, as if incorporated herein.

The provisions of Chapters I, II and II-C shall not apply to construction operations defined herein which may by law or with the approval of a governmental agency be performed by others not required to comply with the provisions of this Code.

Article II.—Definitions.

Section 1.—Highway Contractor.

The term "Highway Contractor" is herein defined to mean without limitation, any individual, partnership, association, trust, trustee, trustee in bankruptcy, receiver, corporation or agency which undertakes whether by formal contract or otherwise, to direct, superintend, coordinate and execute, either directly or through others, the work of constructing, substantially in its entirety, any fixed structure and other improvements or modifications thereof, or an addition and repair thereto, where custom recognizes said work and services as highway contracting or construction, including any operation performed as an incidental part of a contract or project therefor and including without limitation, projects and services such as transportation with equipment owned and operated by the highway contractor in the construction of his own contract; highway bridges of a contract value of $500,000,000 and under; and roads, streets, alleys, sidewalks, parkways, parking areas, bridle paths, athletic fields, highway separations, conduits, airports, service mains, and sewers in trenches; excluding any such operation aggregating in its entirety less than the sum of $300.00.

Section 2.—Highway Contracting.

The term "Highway Contracting" as used herein shall mean without limitation operations performed by a highway contractor as defined in the foregoing section.

Section 3.—Association.

The term "Association" as used herein shall mean the Associated General Contractors of America.

Section 4.—Visiting Contractor.

The term "Visiting Contractor" as used herein shall mean any Highway-Contractor who estimates, bids and/or builds, a project defined herein as highway contracting, in a State, territory of the United States or the District of Columbia, different in regional control from that in which he customarily maintains an office.

Section 5.—Sub-Contractor.

The term "Sub-contractor" as used herein shall mean any one other than an employee who enters into a contract for the performance of an act with a Highway Contractor who has already contrated or otherwise arranged for its performance.

Section 6.—Construction Code Authority.

The term "Construction Code Authority" as used herein shall mean the Construction Code Authority as established by the Code of Fair Competition for the Construction Industry in Chapter I, Article IV, Section I.

Section 7.—Divisional Code Authority.

The term "Divisional Code Authority" as used herein shall mean the Divisional Code Authority as established for the General Contractors' Division of the Construction Industry in Chapter II, Article II, Section I.

Section 8.—National Administrative Committee.

The term "National Administrative Committee" as used herein shall mean the National Administrative Committee for Highway Contractors.

Section 9.—State Committee.

The term "State Committee" shall mean a committee representing a State or a territory of the United States or the District of Columbia for the purpose of administering the Code applicable to this sub-division within the State, territory or district.

Section 10.—State.

The term "State" as used herein shall mean a State or a territory of the United States or the District of Columbia.

Section 11.—Region or Locality.

The term "Region or Locality" as used herein shall mean a portion of a State, territory of the United States or the District of Columbia in which the conditions are such as to require special or differential consideration.

Section 12.—Effective Date.

The term "Effective Date" as used herein shall mean the thirtieth (30) day after the approval of this Chapter by the President.

Article III.—Hours, Wages and Conditions of Employment.

Section 1.—Other Hours and Wages—Exceptions.

Conditions stated in the basic Code (Chapter I, Article III) are to govern the Highway Contractor, except that field time keepers and field accountants shall be classified as professional, executive, or supervisory as provided for in Chapter I, Article III, Section 2, Sub-section B, Paragraph 3 (a).

Article IV.—Administration.

To further effectuate the policies of the Act and to administer this Code within the Highway Contractors' Sub-division, there shall be and there is hereby established a National Administrative Committee for Highway Contractors.

Section 1.—National Administrative Committee.

The National Administrative Committee shall be composed of thirteen (13) members, eight (8) of whom shall be members of the Association, appointed for a term of two years by the Highway Contractor members of the Divisional Code Authority provided for in Chapter II, Article II, Section I, Paragraph A, and each member so appointed shall serve until he or his successor is appointed in like manner. The eight (8) members so appointed shall appoint to the National Administrative Committee for a term of two years and to be approved by the Administrator, five (5) additional persons engaged in the business of highway contracting, who are not at the time of selection rep-

*As approved by the Executive Committee of the Highway Contractors Code Committee March 26, 1934.

resentative of or responsible to members of the Association, and each of the five (5) members so appointed shall serve until he is so reappointed or his successor selected, or until he or his successor shall be selected by the non-members of the Association pursuant to a method of selection satisfactory to and approved by the Administrator.

Section 2.—The Powers and Duties of the National Administrative Committee.

(a) The powers and duties of the National Administrative Committee are as set forth in Chapter II, Article II, Sub-Article B, Section 2, Paragraphs (a), (b), (c), (d) and (e) and in addition thereto the following:

(b) The National Administrative Committee shall appoint committees for each of the several States to be known as State Committees. Such State Committee shall consist of not less than three (3) or more than fifteen (15) persons engaged in the business of Highway Contracting. These members are to be appointed by the National Administrative Committee from nominations made in writing to the National Administrative Committee by the truly representative group or organization of Highway Contractors in the State.

(c) The National Administrative Committee shall delegate to each State Committee such powers and duties as may be necessary to enforce the provisions of the Code applicable to this subdivision in each State, and in addition thereto the authority to prescribe bidding rules requiring the inclusion in each bid of all direct and indirect costs properly defined, and methods for administering such bidding rules and such bidding rules and methods shall apply to all highway contractors operating within the State for which such bidding rules and methods for administering the same have been prescribed.

(d) In case a State Committee is not established as above provided and/or in case of rules not being prescribed by a State Committee after a lapse of sixty (60) days next following the effective date of this Chapter II-C, the National Administrative Committee shall prescribe such rules, regulations and methods for a State, and provide for their administration and enforcement and all such rules, regulations and methods when approved by the Divisional Code Authority shall apply to all highway contractors in such State.

(e) The National Administrative Committee shall prescribe standards of accounting, cost keeping and estimating for the purpose of determining a fair price for services or products, and systems for the interchange of such information subsequent to the award of specific work shall be established. Such standards shall be subject to the approval of the Divisional Code Authority and of the Administrator.

(f) In lieu of the provision of Chapter I, Article VII, Section 14, the National Administrative Committee of this sub-division shall provide a satisfactory method of checking bids for any state, region or locality, if in its opinion fair competition demands such action.

(g) It shall defray expenses in administering this Code from the equitable apportionment it receives from the Division Code Authority from the funds derived as authorized in Chapter II, Article II-A, Section 2, Paragraph (b).

Section 3.—The Powers and Duties of State Committees.

(a) The State Committee may establish local and regional areas and may appoint committees for such regions or localities to be known as Local Committees when requested to do so by any representative group or organization of highway contractors in the region or locality, provided, however, that the State Committee shall not establish regions or localities nor appoint committees for same unless and until the enrolled contractors of the state have approved such establishment and appointments by a majority vote. This Local Committee when appointed shall consist of not less than three (3) nor more than seven (7) Highway Contractors appointed by the State Committee from nominations made in writing to the State Committee by any representative group or organization of Highway Contractors in that region or locality. This Local Committee shall submit to the State Committee all rules and regulations to govern the region or locality, and when approved by the State Committee shall be administered by the local or regional committee.

(b) The State Committee shall prescribe registration forms subject to the approval of the National Committee and require for the purpose of making effective the provisions of Chapter II-C that all highway contractors register with the State Committee or its designated agency before becoming eligible to bid on work defined as highway contracting in Article II, Section 1 hereof.

(c) The State Committee shall prescribe bidding rules and methods for administering such rules as provided in Article IV, Section 2, Paragraph (c) of this chapter.

(d) The State Committee shall prescribe the use of the standards and systems as set forth in Article IV, Section 2, Paragraph (4) of this chapter.

Article V.—Trade Practices.

Section 1.—Financing.

A highway contractor shall not permit or require sub-contractors, corporate surety companies, or material vendors, to finance his accounts.

Section 2.—Subletting.

(a) Unless otherwise prescribed by the State Committee as provided in Article IV, Section 3, Paragraph (c) of this chapter, a highway contractor shall perform with his own organization and with the assistance of workmen under his immediate superintendence work of a value not less than eighty (80) per cent of the value of all work embraced in the contract exclusive of items not commonly found in contracts for similar work, or which require highly specialized knowledge, craftsmanship and/or equipment not ordinarily available in the organizations of contractors performing work of the character embraced in the contract.

(b) The provisions of Chapter II-C shall apply to sub-contractors.

Section 3.—Equipment Rental Provisions.

Any highway contractor renting or leasing equipment shall do so under rental schedules prescribed by the state committee.

Section 4.—Visiting Contractor.

A visiting contractor shall be bound by all of the rules, regulations and agreements of the state in which he operates or proposes to operate.

Article VI.—Modification.

Subject to the provisions of Chapter I, Article IV, Sub-Article B, Section 2 (c) the provisions of this chapter, except as to provisions required by the Act, may be modified on the basis of experience or changes in circumstances, such modifications to be based upon application to the Administrator and such notice and hearing as he shall specify the thirtieth (30) day after it is approved.

This sub-divisional Chapter II-C shall become effective thirty (30) days after its approval by the President.

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Trade Promotion Tour to the Soviet Union

A new development of United States-Soviet recognition is a Trade Promotion Tour to the Soviet Union now being organized by the American Russian Chamber of Commerce, which is extending invitations to Chambers of Commerce in this country and to various trade groups and technical societies to appoint delegates to join this group.

The purpose of this Mission is to enable American business executives, manufacturers, industrialists and bankers to visit and study at first hand the great new mining and manufacturing centers which have been developed in the Soviet Union within the last few years, and to give them an opportunity to survey the Soviet Union as a prospective market for their products. Upon their return to Moscow at the end of the tour, a conference will be arranged between the members of the delegation and Soviet industrial leaders. This Trade Promotion Delegation will sail from New York on June 21st on the S. S. Manhattan. The travel details of this movement are in the hands of the American Express Company, which has arranged the itinerary to allow time for remaining in Russia and either stopping over or traveling in Europe at the end of the conference in Moscow.

The Modern Churn Drill
In Rock Cuts

By H. K. CHURCH

Research Engineer, Keystone Driller Co.

THE purpose of this article is to discuss some of the most important recent developments in churn drill design and construction, as well as their operation and performance which are of special interest to contractors who do more or less rock excavation on public works projects.

The first and most obvious development is in the matter of mounting or mobility. Compact, all-steel drills are now made, suitable for mounting on a motor truck for quick, long distance travel. For jobs in hilly, rough country, drills mounted on full-crawlers are now made which will go wherever a tractor will go. One of these full-crawler mounted drills can be moved from hole to hole, on steep hillsides, with the mast or derrick raised and ready for drilling, greatly reducing moving and setting-up time.

The derrick of modern drills is made in two telescoping parts, so as to facilitate travel through woods and on sharp curves. Fire and other hazards are eliminated by all-steel construction including derrick, frame, and walking beams. Belts are replaced with chain drives, and manilla rope with wire cable.

As on the power shovel, a gasoline, Diesel, or electric motor has replaced the old steam engine and boiler. Ball or roller bearings are used on all fast revolving parts.

Wire Line Drilling.—Drill operators have always maintained that in order to obtain the best results, one must drill "on the stretch of the rope, that is, the rope must never be slack. The object is to secure smart, rhythmic action of the tools, and prevent excessive jar on the pickup, which would shake the rig to pieces. However, in drilling "on the stretch of the rope" one partly sacrifices the free drop of the tools. The practice is, nevertheless, to a certain extent necessary in order to get the tools away from the bottom of the hole without delay and excessive vibration on the machine. But as a manila rope has a very large amount of stretch, it will accommodate itself within very liberal limits to infrequent feeding of the rope to compensate for the footage drilled. The driller and his helper, not having to watch the feeding very closely, are prone to fall into a leisurely stride.

Native Sandstone Ledge at Brady's Run, Beaver County, Pa., Where Rock Was Secured for Road Base. After Drilling with Jack-hammers and "Mudcapping" for Several Days, with Indifferent Results, a Crawler-Mounted, All-Steel, Churn Drill Was Brought in and in a Day and a Half Drilled Three Holes, Bringing Down About 2,000 Tons of Rock in the First Shot

With wire line drilling, a different technique must be adopted. The steel cable has a very limited amount of stretch. Therefore, shocks absorbers are provided for cushioning the shock of picking up the tools on the rebound. The amount of compression of the shock absorbers is, of course, a constant factor. Therefore, payout of line must be done more frequently than with manila, keeping the driller more on the alert. This necessary alertness, however, carries its own reward in increased footage. Just why this is so is a little difficult to understand, but an explanation is attempted in Fig. 1, with caption.

An additional advantage of the use of wire rope over manila line is the tendency to drill a straighter and truer hole. The swivel socket, peculiar to the use of wire rope, allows the bit to rotate slowly and uniformly, without the necessity for hand turning of the drill line. This self turning characteristic is desirable in drilling all kinds of materials.

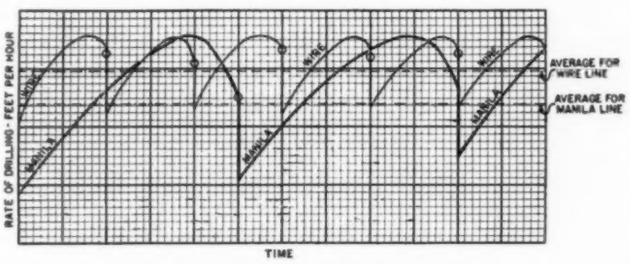
It has been aptly stated that manila line will apologize for a poor driller, but wire line will not. The ideal method of drilling is to pay out the drilling cable in short and uniform increments to maintain the most advantageous striking tension on the cable. The tendency of the man accustomed to drilling with manila line, is to neglect the payout of the cable, and when he finally does so, to pay out an excessive amount, so that the rate of drilling will fluctuate considerably between successive feeding out of cable. Efficiency drops abruptly when the rope is let out, increases slowly to a maximum, and then drops off again.

When wire cable is used, the machine itself warns the driller when rope tension becomes too great. The shock absorbers "bottom" with a sharp clash and the entire rig vibrates excessively because of the rigidity of the steel cable. The driller learns to avoid this by paying out line more frequently, resulting in higher overall efficiency.

The use of steel cable for

drilling is not new. Since the beginning of this century, engineers have played with the idea. Steel cable is so much stronger and more durable, yet so low in first cost, that it offers a big advantage in economy compared with manila. Various shock-absorbing devices have been brought out from time to time, the earliest ones over 25 years ago. But it is only within the past three or four years that they have become perfected.

Comparison of Old and New Machine.—How one of these relatively small, compact, mobile, modern wire line drills compares in output with the old familiar wood frame, manila rope machines, is strikingly illustrated by the following data obtained from a recent drilling job. It involved drilling of hard, fissured, and seamed trap



O INDICATES FEEDING OF LINE. INTERVALS OF TIME BETWEEN FEEDING OF LINE ASSUMED TO BE ABOUT THREE TIMES LONGER FOR MANILA THAN FOR WIRE LINE

Fig. 1.—This Diagram Illustrates What Experienced Wire Line Drillers Believe to Account Largely for the Fact That One Can "Make Hole" Faster, on the Average, with Wire Line, Properly Fed. It Should Be Noted That the Maximum Attainable Rate of "Making Hole" with Wire and Manila Line, Under Identical Conditions, Is the Same, But the Minimum Speed is Lower with Manila. Distance Drilled Between Successive Feedings of Line Being Assumed to Be Three Times Greater with Manila Line, There Is a Greater Drop of Drilling Progress Following Each Feeding, and the Average Rate of Progress Is Therefore Lower. Feeding Is Indicated by o, and the Rate of Speed in Feet Per Hour Is Observed in the Curves to Drop Sharply After Each Feeding. Actual Experience Indicates That This Drop Will Vary Somewhat in Proportion to the Amount of Line Paid Out Each Time

rock, using two drills, one old and one new, swinging the same weight of tools:

Particulars	Old Machine	New Machine
Drilling Line	Manila	Steel
Weight of Drill Steel, complete	1,350 lb.	1,350 lb.
Lenth of Stroke at hole	30 in.	37 in.
Frequency of Strokes, per minute	47	53
Gross Energy delivery, foot-pounds per minute	159,000	221,000
Footage drilled per million foot-pounds of energy	.102	.153
Rate of Drilling, feet per minute	0.163	.0339

If the old drill referred to in the table is assumed to represent 100 per cent in all particulars, the new drill will represent the following percentages in the same particulars:

Particulars	Old Drill Per Cent	New Drill Per Cent
Weight of Drill Steel	100	100
Length of stroke at hole	100	123
Frequency of Strokes, per minute	100	113
Energy Delivered, foot-pounds per minute	100	139
Footage drilled per million ft.-lbs. energy	100	150
Rate of Drilling, feet per minute	100	208

The first enlightening fact revealed by these figures, a fact very often overlooked by drillers, is that a relatively small increase in length and frequency of stroke, results in a surprisingly great increase in gross energy output. If, in this case, there had also been a small increase in weight of drill steel, the increase in energy output would have been correspondingly greater.

But even those of us who have made the apparently logical assumption that the rate of drilling is in direct proportion to energy output, in terms of ft.-lbs. per minute, will be surprised at the 50 per cent greater output per million ft.-lbs. of energy delivered by the new drill. This greater efficiency of the new drill is more difficult to explain, yet it is a big factor which can be reckoned with in all cases in which a manila line, wood-frame drill is used on the same job and under the same conditions as a new all-steel machine, equipped with wire line and steel spring shock absorbers.

There are two explanations, each accounting for a part of the extra footage drilled. First, the better drilling technique which must be adopted where wire line is used, as explained in the following. Secondly, the smart action of the walking beam, permitting the freest possible drop of the tools consistent with drilling "on the spring of the line," and the quickest re-bound. Modern all-steel wire line drilling machines, equipped with steel spring shock absorbers, apparently have a substantial advantage in both of these respects.

Drilling Costs.—Blast hole drilling is an operation which calls for no materials with the exception of an occasional repair part, drill steel and drilling cable. The daily operating expenses are practically a constant, and if the rate of production in tons of rock per day increases, we may, therefore, expect the cost per cubic yard or ton of rock to decrease almost in the same proportion.

Rock Cut on Philadelphia-Trenton Highway, Near Neshaminy Falls, Pa. About 10 Ft. of Overburden Was Removed by Power Shovels, Before Starting to Drill. It Was Then Found That Pneumatic Drills Were Not Suited for the Conditions, and the Three Churn Drills Were Moved in.

For the latest type of all-steel, wire line, chain driven drill, complete with tools, one may figure 25 per cent annually for depreciation, interest, taxes, repairs and drill steel replacements. Assuming 150 working days, the daily fixed charge for a full-crawler mounted machine costing $4,000 would be $6.67. For the same machine, without crawlers, but mounted on a motor truck, costing $2,500, the fixed charge per working day would be $4.16.

Assuming average wage scales, full cable, and bit dressing costs, the daily operating expense becomes:

	Crawler Machine	Truck Mounted
Daily fixed charge	$ 6.67	$ 4.16
10 gals. gasoline and 1 qt. oil	1.70	1.70
Driller's wage	5.00	5.00
Helper's wage	3.00	3.00
Tool dressing, water supply, etc	7.50	7.50
Cable—150 ft., $25.00 400 hrs. life—8 hr. day	.50	.50
Daily Operating Cost	$24.37	$21.86

Big Rock Cut at Neshaminy Falls, Pa., Showing Fragmentation in Primary Blasting of Hard and Soft Rock. Considerable "Blockholing" or Secondary Drilling with Jackhammers Was Necessary to Bring All the Rock Down to Suitable Size for Handling with Small Shovels. There Was No Appreciable Difference in Fragmentation from Small Wagon Drill Holes Spaced Closely Together, and Large Churn Drill Holes, Spaced Farther Apart

One advantage peculiar to churn drill operation is that contractors who do not find it economical to own and operate their own equipment, may sublet their rock drilling to experienced water well drillers who are to be found in and around all centers of population. It is advisable, when doing this, first to find out something about the kind of equipment owned by the driller, so as to make sure that the rock drilling will be completed within the specified time. Light water well drills are as unsuitable for deep drilling in heavy rock, as are jackhammers where wagon drills should be used.

It pays to be alert to the possibilities of using churn drills for primary blast hole drilling in many places, especially those enumerated in the following:

a. Where considerable yardage has to be moved and speeding up completion of job is necessary.
b. Where depth is upwards of 20 ft.
c. Where rock is very hard, or contains loose fragments, and clay, or is pocketed, seamed, inclined and fissured, causing sticking of drill steel.
d. Where there is considerable overburden which would have to be first removed if pneumatc tools are used, but can be drilled through with the churn drill, blasted and removed with the rock.
e. In cuts less than 20 ft. deep where one or more of conditions stated under "c" and "d" obtain.

It should be born in mind that the use of the churn drill holes usually eliminates the necessity of springing and redrilling the holes.

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Laboratory Traffic Tests for Low-Cost Road Types

In recent months, two laboratories in Washington have built and put into operation laboratory apparatus for tests of low-cost road types. The apparatus may be used also to study subgrades, tire wear, etc. The following notes on these laboratories are taken from March Highway Research Abstracts:

The apparatus in the laboratory of the National Crushed Stone Association was described in detail in the May-June, 1932, issue of the Crushed Stone Journal. The apparatus consists of a circular track 14 ft. in mean diameter upon which the traffic is operated. The track is a concrete channel in which surfaces may be placed 18 in. wide and with a maximum depth of 6 in. Water may be circulated through pipes in the concrete base to control the temperature of the materials under test. The traffic is applied by a wheel mounted at the end of a radial arm which is driven by power applied through a vertical rotating axle at the center of the track. The wheel is motor truck wheel equipped with a 7 by 20 in. pneumatic tire inflated to 55 lb. per square inch. The wheel may be loaded to 1,900 lb. and the speed may be varied from 3 to 12 miles per hour. For preparing the surfaces, the wheel is replaced with a steel roller, 3 ft. in diameter and 6 in. wide.

Use of the machine has proven it a valuable means of determining quickly what the service behavior of materials will be.

The apparatus at the laboratory of the U. S. Bureau of Public Roads is described in the January, 1934, issue of Public Roads. In this apparatus the circular track is 12 ft. in mean diameter. The track is a concrete trough 18 in. wide and 12 in. deep, allowing various depths of base materials below the bituminous test surfaces. Along the inside of the track is a smaller trough which may be used as a reservoir to introduce water into the base material. Traffic is provided by two automobile wheels mounted on the two ends of an arm rotated by a vertical shaft at the center of the track. Each wheel load (including tire, wheel, cross member) is 800 lb. Either wheel may be shifted to place its path at any point on the test surface. The speeds are 4½, 6 or 9 miles per hour. Use up to this time indicates that the apparatus will be very useful in studying the many factors involved in the performance of low-cost bituminous surfaces.

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PUBLIC WORKS AND SANITATION OFFICIALS TO MEET IN SEPTEMBER.—The 15th annual conference of the International Association of Public Works Officials will be held Sept. 26, 27, and 28 at the Sagamore Hotel, Rochester, N. Y. A. M. Anderson, 100 North La Salle St., Chicago, Ill., is Secretary.

New Concrete Block Pavement Laid on Albany Post Road, New York

A NEW non-skid pavement has been laid on the Albany Post Road, one of the main arteries of travel in New York state, for heavy and fast vehicular traffic. This experimental stretch of road 350 ft. long is between Ossining and Scarsboro.

General Features of New Pavement.—This new pavement is called "Ultimite" and was invented by Louis F. Hewett, member of American Society of Civil Engineers. The block is manufactured by placing, by hand, face downward in the form, fragments of granite or other approved stone, about 2½ in. in depth, with surface dimensions of about 2 to 3½ in. The interstices are then filled with grout and the remainder of the form, to the required depth, whether 4 or 5 in., is filled with compressed concrete. The concrete of the block has tested up to 7,000 lb. per square inch and the block itself up to 10,000 lb.

The blocks are cured for about 30 days, and then are piled alongside of the street or road to be resurfaced. The base is then prepared by rolling in broken stone to a depth of about 5 in. with a 15-ton roller. It is then covered with a dry mortar cushion to a depth of 1 in. This cushion is screeded to the desired crown and grade; and the blocks are placed by hand in rows breaking joints in alternate courses. The pavement is then rolled and the joints (about ¼ in. wide) are filled with a joint filler of either cement grout or asphalt.

Constructing Post Road Experimental Section.—The Post Road is 34 ft. wide with a center section of brick on concrete foundation 20 ft. in width, and two concrete shoulders of about 7 ft. in width. One-half of the road was shut off and about 12 ft. of the old brick roadway removed and the concrete base cleaned. The old concrete base was very uneven in surface and cracked about every 4 ft. longitudinally and about 12 ft. transversely, having settled almost 2 in. in places. The concrete was not repaired, this being deemed unnecessary.

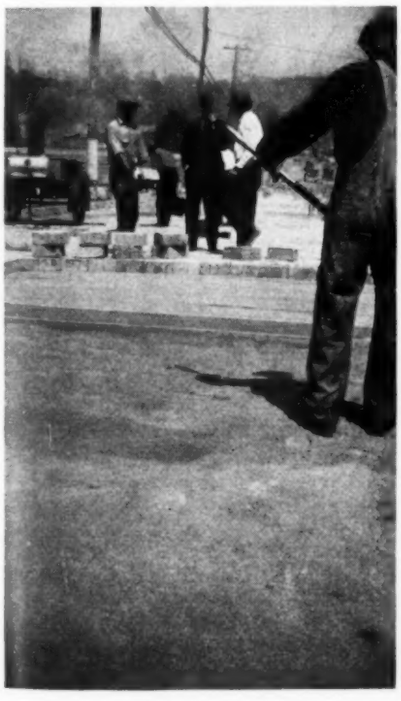
The mortar cushion of 1 part cement to 4 parts sand was spread on this concrete and screeded to a crown of 2½ in. in order to clear the concrete base—6 in. being required for the placing of the new pavement. Due to the unevenness of this concrete base, the cushion varied in depth; there were places where it was less than ½ in. and other places where the cushion was almost 2 in.

The blocks were placed on this cushion (using special tongs) in rows perpendicular to the concrete shoulders and meeting the uneven surface of the concrete shoulder as closely as possible without affecting the grade of the new pavement. The blocks were paved to a ¼ in. joint which was filled with an asphalt mixture. When the first side of the road was completed it was covered with a thin layer of sand and the roadway was immediately opened to traffic. The other side was then barracaded and paved similarly. The pavement was placed as fast as the old roadway was removed.

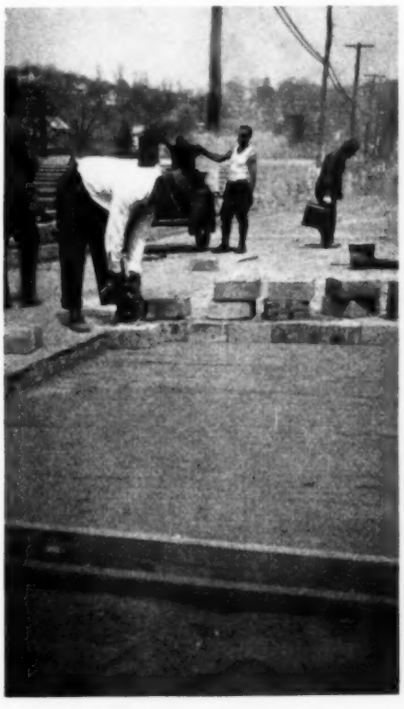
While "Ultimite" pavement should be rolled to an even grade before the filling of the joints, in this work no roller was available and the blocks were hand tamped.

No skilled labor was used in the work. Only one man had any previous experience with this new type pavement—yet the blocks were paved to a true grade there being no more than ¼ in. deviation under a 16 ft. straight edge.

The cost of labor for paving including the mixing and screeding of cushion, carrying and paving of blocks, and



Placing Cushion



Screeding and Paving

Pouring Joints

Views Showing Construction of Experimental Section of New Pavement on the Albany Post Road

Showing Half Road Paved

the pouring of the joints averaged less than 20 ct. per square yard. The asphalt filler cost 7 ct. per square yard, and mortar cushion 13 ct. per square yard. One man placed an average of 21 sq. yd. per hour.

The experimental section of the Albany Post Road was paved by the maintenance forces of the Department of State Highways. Mr. Bixby is the Division Engineer, and Mr. Brady was in charge of the forces doing the work.

Repairing Openings.—An experiment was made to determine the cost of repairing openings in this pavement. Six Rows were removed after being completed, and replaced by other blocks in 40 minutes by one man at a cost of 8 ct. per square yard. There was no visible sign of a patch being made. The asphalt was then removed from the blocks replaced, and both the filler and the blocks were used again proving the low cost of repairs and the salvage value of the blocks.

Another piece of "Ultimite" pavement was recently placed in the east entrance of the storage yards of the New York Edison Co. on East 41st St., New York.

The offices of the Ultimite Paving Block Corporation of America are at 60 East 42nd St., New York City. The first plant will soon be opened at the quarries of the Cape Ann Granite Co. at Rockport, Mass. Other points of manufacture and representation are now being arranged.

Tests of Rubber, Cast Iron and Gritstone Paving in Milan, Italy

The engineers of the Commune of Milan, Italy, are now making tests of rubber, cast iron and hard sandstone as paving material, according to a report of U. S. Vice Consul Paul D. Thompson to the Automotive Trade Division of the U. S. Bureau of Commerce.

The experiment with composition rubber tiles or blocks is being carried on in Milan on a section of street about 100 ft. in length, in a busy part of the city where traffic, both vehicular and pedestrian, is heavy. Similar experiments are reported to be under way in the city of Turin. This type of paving was exhibited in April, 1933, at the Annual Sample Fair of Milan, by one of the principal manufacturers of the rubber tiles, but it had not yet been tested in Italy by actual use on a city street under heavy traffic over a considerable period.

The Milan experiment is being made with thin rectangular tiles of rubber composition, about 11 by 8 in. in size, and 8/10ths of an inch thick, with dovetailed edges, laid in a thin asphalt cushion on an ordinary stone and concrete foundation 8 in. deep.

The test with cast iron as a material is being made on a section of street about 180 ft. long and 40 ft. wide. An ordinary stone and concrete foundation about 8 in. deep is laid and allowed to harden. The iron blocks or plates are then laid by hand on a thin layer of cold powdered asphalt. The blocks are of iron cast in one piece, triangular in shape, hollowed out on the under side, and about 1½ in. thick at the edges. Two shapes are used, the principal one being an equilateral triangle with 8-in. sides, the other being a section of the first, a little less than half of it, for use at the end of each row of blocks and along the gutters. The larger size weighs around 5 lb. The surface of each block is roughened by small knobs in the casting to make it nonskid. A light binding of hot tar is applied along the junctures of the blocks to further insure their immovability. A light covering of gravel and sand is used to form a smoother running surface.

The Milan experiment with bricks or blocks of hard sandstone (gritstone) is on the same street with the cast iron blocks. The blocks are about 8 by 4 by 2⅓ in. in size, with the appearance of glazed yellow brick. They have a special feature in a projecting lower edging which holds the blocks apart uniformly about ½ in., and facilitates rapid and accurate laying. The space thus provided is filled with an asphalt composite which forms a smooth compact surface with the blocks. This paving presents a smoother surface than the cast iron, but a little covering of gravel or crushed rocks may be used to improve the adhesion.

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A Correction.—In an article on page 156 of the April issue describing the transportation of a 100-ton transformer on a special trailer, it was stated that the hauling was done by Leyland trucks. We have been advised that practically all the haulage of this special trailer was done by a 110-HP. Walter truck alone and only when crossing heavy grades was assistance required of the additional trucks shown in the illustration at the top of the page.

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Exclusive Parking Space for Tourists.—Three cities in the United States have set aside a full block in their business districts for the use of out-of-state motorists only. In these cities, Pasadena, Wooster and Jacksonville, the business men claim that this facility has paid big dividends.

RECENT DEVELOPMENTS *In Grade Separation Structures*

By CHARLES P. DISNEY

Bridge Engineer, Central Region, Canadian National Railways, Toronto, Ont.

During recent years on the Canadian National Railways there has been a gradual and steady development in the designing of both railway and highway structures. This development has been more or less gradual and has not attracted very much outside attention. However, during the last two or three years changes from conventional design have become so drastic that they are now attracting considerable attention. The important features of these structures are their shallow decks, their low cost, their simple construction and their easy maintenance. In a paper presented last March before the Western Society of Engineers, Mr. Disney describes six different types in use on his railway. An abstract of his paper follows.

THIS paper will be confined entirely to structures over highways and streets, that is, structures usually referred to as subways.

During the past ten years the Central Region of the Canadian National Railways, under my direction, has designed and built a considerable number of these subways. In the course of this work we have designed many different types of structures. As a result, a process of elimination seems to have gradually taken place; so much so that at the present time we feel that practically any grade separation project can be taken care of by one of six different types, that is, we think that the six structures described in this paper cover practically every condition that one would meet in grade separation work, or, in other words, in subway design.

It is the intention in this paper to discuss each one of these six types of design. It should be kept in mind that the sequence has nothing to do with their relative merits; each type of design has its special use.

Type 1: Simple Concrete Beam Without Ties or Ballast.—The first type consists of a simple reinforced concrete beam, poured in place, without any ties or ballast. We consider it suitable for use where railway traffic does not have to be handled during construction, where obtaining the minimum headroom is important, and where the clear span does not exceed 60 ft. If, however, it is not important to obtain a minimum distance from base of rail to underside of clearance, we would use a rigid, fixed-frame design, as it costs very little more; has a much finer appearance, and is, to our mind, a more rigid and better bridge.

This type consists of a simple beam resting on two gravity abutments. The overall length of the beam in a typical subway, which was built in 1931 at St. Lambert, Que., is 57 ft., 11¾ in. on the skew, giving a clear unobstructed roadway of 42 ft. at right angles to the face of the abutments. The thickness of the slab is only 4 ft., and as the rails are fastened directly to the slab (there being no ties nor ballast carrying these rails) this same distance of 4 ft. is the distance from base of rail to underside of structure.

This dimension in subway design is always a most important one, that is, the smaller the dimension from base of rail to underside of structure, the more economical the structure will be. There is one dimension always fixed on a subway, that is, the distance from the top of the finished roadway to the underside of the structure must not be less than 14 ft. This being the case, it is usually very important to get the distance from base of rail to underside of structure as small as possible in order to cut the cost of drainage, sewers, property damages, etc., to a minimum. By cutting out the ties and ballast on all these structures, a saving at one stroke of from 15 to 18 in. has been made, and at the same time the most perfect possible track structure has been obtained.

Some of these track structures have been in use for over six years; they have given perfect satisfaction. When they were first introduced, as usual a lot of people prophesied that difficulties would occur. According to them there would be a shock when the train came off the approach grade onto the structure of the bridge. The fact that any engine coming off any grade onto the backwall of any abutment on any bridge created exactly the same condition as existed on these structures did not occur to them. They still shook their heads dolefully and predicted the worst. After six years of operation they are still trying to find out just what it is they were so gloomy about. The fact of the matter is that there is absolutely no shock in coming off the approach grade onto these structures.

The riding qualities of this track are easily the best on any portion of our tracks, in that there are no low joints, there is no bending or spreading of the rails: a perfect track is always provided. Moreover, the track is perfectly silent, due partly to the oak strip and partly to the fact that they are on a heavy mass of reinforced concrete. Where these subways have been built in cities, it has been remarked how noiseless they are.

No Maintenance Required.—A most important consideration regarding this new type of track structure on bridges is that there is no maintenance; that is, there are no timber ties to be renewed; no ballast to be constantly tamped and packed around the ties; there is no accumulation of dirt and filth on the track, which is especially important in terminals and cities. The track can be kept spotlessly clean with a hose or broom and always presents a fine and neat appearance.

The saving of 15 in. of headroom by the elimination of ballast in some instances that I know of has had, and in others would have had, an important economic result. One case I know of, every inch of height that was saved in the depth of the subway meant a saving of $100,000 in the grading of an adjoining yard. Therefore, a saving of 15 in. in headroom by the adoption of this type of structure would have effected a saving of $1,500,000: it was not saved, as the old type of ballasted track was used.

If the line had been under traffic, the slab would have been pre-cast and dropped into place between trains,

which is only a matter of a few minutes. This feature of speedy erection will be dealt with under another type of structure.

An important feature of this whole structure is the fact that once it is built there is no maintenance cost attached to it. It is the one permanent type of structure on the railway that can really be called permanent: every other type of so-called permanent structure on the railway requires maintenance. These structures have nothing on them that should ever need renewal, except the rails. As regards the appearance of these structures, they speak for themselves: they are simple and clean-cut and quite pleasing to the eye.

An important feature of all these structures is that, owing to the fact that most of them have tensile and compressive reinforcing with diagonal shear bars between them, it has been possible to spot weld the reinforcing into separate units forming trusses. This spot welding has been done at the rolling mills at very little extra cost and has resulted in a very considerable saving in the assembling of the reinforcing. A job on which would ordinarily take eight days to assemble and wire the reinforcing can be done in about two days if the trusses are assembled and spot welded. In addition to the saving in time and labor, there is the added accuracy in placing the reinforcing: it goes exactly where you figure on it going.

Type 2: Pre-Cast Concrete Beam.—The second type is a reinforced concrete simple beam, pre-cast and dropped into place, no ties or ballast. We consider it suitable for use where railway traffic has to be maintained during construction and where the clear span does not exceed 60 ft.

This structure is identical to Type No. 1, except that instead of its being poured in place, the slabs are pre-cast and lifted into place between trains by two locomotive cranes. Everything that has been said regarding subways of Type No. 1 applies equally to subways of Type No. 2, except that owing to the fact of this type being constructed under traffic, the rigid fixed-frame design could not be substituted.

Type 3: Reinforced Concrete Slab.—Type 3 consists of a reinforced concrete slab continuous over a center support, cast in place, with concrete ties but no ballast. We consider it suitable for use where railway traffic does not have to be maintained during construction of the subway; where a center pier is permitted, and where the clear span on either side of the pier does not exceed 50 ft., that is, where the total length of the continuous slab does not exceed 110 ft.

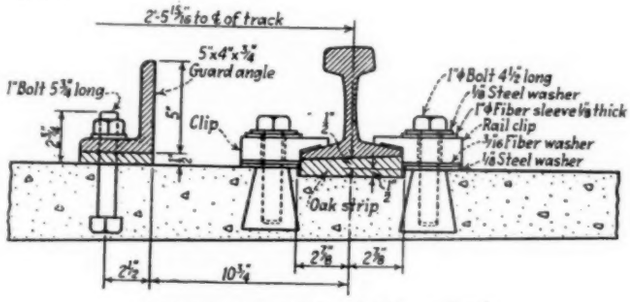
An example of this type is the Richmond Street subway, London, Ontario, built in 1931, and designed for Cooper's E.60 loading, as all these structures are. Also, there is a roadway designed for 20-ton trucks.

The extreme length of slab overall in this case is 73 ft., 9 in. The depth from base of rail to underside of slab is only 3 ft. It carries 13 railway tracks, one 24-ft., 3-in. roadway, one 3-ft., 9-in., sidewalk on the north side, and one 7-ft., 11½-in. sidewalk on the south side.

After the concrete slab was poured and set up, pre-cast concrete ties 5 in. deep, with the necessary rail fittings pre-cast into them were placed on the finished surface of the concrete slab, then the spaces between the concrete ties were filled in with concrete, making a continuous flat surface over the whole track structure. The reason for using concrete ties on this structure was due to the fact that it is right in the middle of a yard terminal, where there are a lot of switches and crossovers, curved tracks, etc.

It was also necessary to have some freedom here to line up the track after the subway was built, as the track layout was not finally completed before the subway was actually constructed. By using these light concrete ties, it was a simple matter to line the tracks up in any way that was necessary. If concrete ties had not been used here, the distance from base of rail to underside of track would only have been 27 in. Of course, this is very remarkable and at least a couple of feet less than on any other possible type of design. The saving in money at this particular location was very marked, due to this remarkably shallow distance from base of rail to underside of bridge, as it was in the heart of the city where sewers, property damages, raising of railway tracks, etc., all came into the picture.

Type 4: Pre-Cast Concrete Beam Continuous Over Center Support.—The fourth type consists of a reinforced concrete beam, pre-cast and continuous over the center support, without ties or ballast. We consider it suitable for use where railway traffic has to be maintained during construction of the bridge and where the clear span does not exceed 45 ft. on either side of the pier, or the total length of the continuous slab does not exceed 96 ft.



Method of Fastening Rails to Deck.

An example of this type is the subway at St. George, Ontario, built in 1932, which gives a single railway track, the total overall length of which is 58 ft., 10 in.

A second example of this type is the St. Francois Street subway at Sherbrooke, built in 1932, designed for Cooper's E.60 loading, carries a single railway track; total overall length 52 ft., 2⅝ in. and distance from base of rail to underside of slab was only 24⅜ in. On this slab the rail is carried directly on an oak strip embedded in the slab. No ties of any kind were used. A remarkable feature of this bridge is that it was erected in 20 minutes between trains.

Type 5: Reinforced Concrete, Rigid Framed Structure.—Type 5 consists of a reinforced concrete, rigid-frame structure built continuous over a center pier, poured in place, with concrete ties but no ballast. We consider it suitable for use where a center support is permissible and where the clear span required on either side of the center support exceeds 50 ft. but does not exceed 100 ft.

An example of this type is the St. Clair Avenue Subway, on the Newmarket Subdivision, built in 1931, designed for Cooper's E.60 loading, where the extreme length of slab along the track is 111 ft. 9¼ in. The distance from center line of pier to end of slab is 65 ft. 10⅝ in.; face to face of abutments is 102 ft. 6¼ in., providing a 100-ft. clear width of street.

It carries a double-track railway on concrete ties, with a concrete platform 8 ft. wide on the east side and a concrete sidewalk 3 ft. wide on the west side. The tracks are on a 2 deg., 30 min. curve, and there is a .5 grade on the bridge. The distance from base of rail to underside of slab is only 4 ft. 4 in., which is very remarkable.

This subway, to our minds, is one of the finest looking structures we have ever built on grade separation work. It is also probably the most economical structure of its

size that we have ever built. The construction was very simple and very rapid, the whole structure proper being poured in one continuous pour, which lasted 72 hours; the placing of steel reinforcing took about five days.

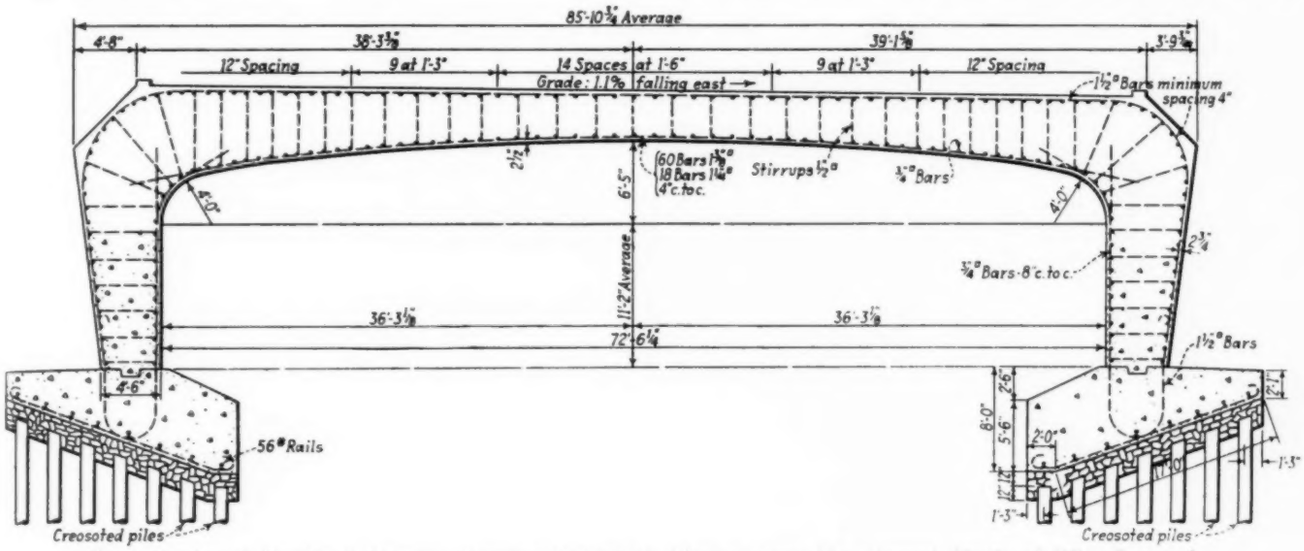
As can be said of all the other previous examples, there is no maintenance or upkeep on this structure. There is no shock whatever coming off the approach grade onto the structure and the track on the structure rides like a billiard table. Further, there is practically no noise caused by the passage of a train, for one can stand underneath this subway and barely tell whether there is a train on it or not.

It is possible that this is the only structure of its kind ever built, that is, a fixed-frame, reinforced concrete structure continuous over but not fastened to the center support, giving a complete reversal of stresses over the center support and involving a set of equations different from the usual run.

Vaudreuil, Que., where a double-track structure carrying the heaviest and fastest traffic probably anywhere in America, was built and put into operation during the last six months.

The clear span, face-to-face of abutment is 72 ft. 6¾ in. The thickness of the slab at the center is only 3 ft. 9 in. The structure was built under traffic. For this and other reasons, it was built as two separate units, that is, one unit was completed first, the traffic then diverted over this completed unit, and the unit carrying the other track was then poured. There is absolutely no connection between the two units, except a strip of sheet lead placed horizontally continuously through the structure to serve as a waterproofing joint.

Owing to the fact that the structure is on a skew, a very heavy torsion stress was produced. If the structure had been built all in one piece, it can readily be seen that the torsion would have been doubled, as when two heavy



Cross Section of Vaudreuil Subway, Showing Method of Placing Stone Mat Around Heads of Piles Supporting the Concrete Footing.

In the St. Clair Avenue Subway, the distance from center line of pier to end of slab is 65 ft. 10⅝ in. If, however, this dimension were much greater than the 65 ft,. that is 80 to 100 ft., it would be necessary to tie each span to the center pier in a similar way to which the span is tied into the abutment, that is, making it two continuous rigid frames tied into the abutment, the center pier and the other abutment, in order to keep the thickness of the slab down and to reduce the bending in the slabs themselves by transferring some of it into the center pier.

Type 6: Reinforced Concrete, Rigid Frame Structure.—The sixth type consists of a reinforced concrete, rigid-frame structure, poured in place, without any ties or ballast. We consider it suitable for use anywhere where a clear span is desired, that is, where no center support is permissible, and where the clear span required does not exceed 100 ft.

This type of structure, of course, cannot be built under single-track traffic. The structure in question, however, was built on a double-track line by single-tracking the line, building half the structure first and then diverting the traffic over the completed part and building the remaining portion of the structure. This, to my mind, is an ideal structure at any place where traffic does not have to be handled during construction, and where obtaining the minimum headroom is not essential. It is cheap and has a fine appearance.

An example of this type has just been completed at

trains met on the bridge, traveling in opposite directions, it would have a tendency to twist and distort twice as much as is now the case with the two portions of the bridge kept separate.

A structure of this type if built on a grade-separation project that was not under traffic could, without doubt, be completely built in three weeks by a contractor who had an efficient plant and who knew his business. This is an outstanding performance. To the best of our knowledge this is about the longest real through rigid-frame structure carrying railway traffic that has been built. It is certainly the only one that has been built without ties and ballast.

It was designed for a very heavy railway loading, that is, Cooper's E.60, and within one month after its erection it has been subjected to the most terrific temperature stresses that, I venture to say, any bridge has had to stand. Within the last two months it has repeatedly been subjected, for days at a time, to a temperature that has been well under 45° below zero, and for as long as five days at a stretch. Keeping in mind the fact that the concrete was only about 28 days when this occurred, one can readily see that this structure has been subjected to the heaviest stresses it will ever be called upon to carry. The structure has come through this test 100 per cent perfect.

In building this structure, every possible care was taken to secure perfect concrete. Vibrators were used. A high early-strength cement was used. Every care was

taken in pouring the concrete to get a continuous and rapid pour, the cement, sand, stone and water were all carefully inspected and analyzed in the laboratory before being used. The concrete was designed for a compressive strength of 3,000 lbs. per square inch at seven days. The actual strength obtained varied from a minimum of 3,200 lbs. per square inch to a maximum of 3,950 lbs., the average being 3,605 lbs.

After two days some of the cylinders were broken and a strength of 2,800 lbs. was obtained.

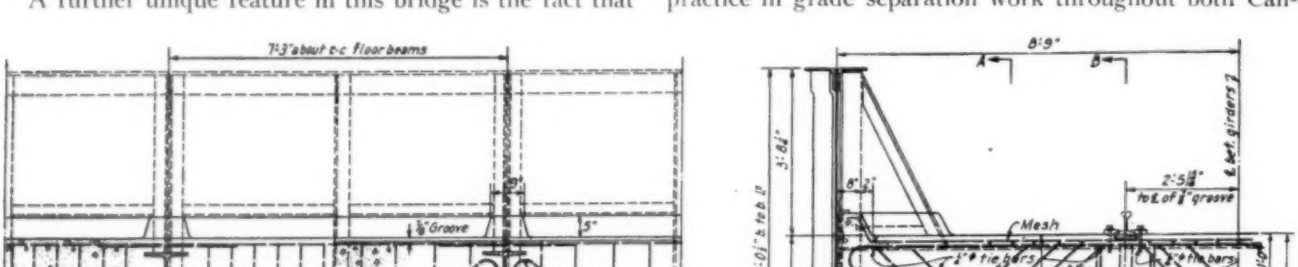
Substructure Construction.—In case there should be any question regarding the type of foundations that one would be justified in building a structure of this kind on, it is to be noted that the foundation in this bridge consists of what is known as "Quebec Blue Clay," which, when dry, has a good bearing capacity, but when wet is a quick sand. Consequently, the foundations were piled, the piles being driven vertically, but cut off on a sloping plane at right angles to the resultant of all stresses throughout the structure.

A further unique feature in this bridge is the fact that carrying an oak strip, that is, there is no ballast or ties on this type of structure.

The saving in this particular bridge, due to the elimination of the numerous steel stringers, concrete filling, waterproofing, ties and ballast, amounted to $5,600, or 17 per cent, considering the superstructure alone. Also the maintenance on this type of structure is considerably reduced. We have built several structures of this type, some important ones being at Charlesbourg Road, Quebec; Shannonville Subway, etc.

This type of deck, to my mind, should be substituted wherever possible when designing new steel railway bridges, as it costs very little more than the ordinary structure carrying the rails on creosoted timber ties, and considerably less than the ballasted type of structure consisting of numerous I-beams concrete-filled, carrying ties and ballast.

Cost Comparisons.—I have made studies of the design of some subways that have been built during the last five years. These cover what is pretty well common practice in grade separation work throughout both Can-



A Concrete Deck Slab and Stringers May Be Used With Steel Girders and Floor Beams.

the piles were cut off one foot below the bottom of the concrete foundations; the clay was then excavated down to a distance of one foot below the cut-off. A 2-ft. layer of crushed stone was then placed and tamped around the piles to a distance of one foot above the top of the piles. The concrete foundations were poured on this stone mat.

It is my contention that, generally speaking, pile foundations should be built this way. If the concrete is placed around and in contact with the head of the piles they may have to take all the load, the earth may carry practically nothing. This can be proven when demolishing an old structure—the earth is seldom in contact with the bottom of the structure. However, if the concrete is not in contact with the piles, which have a layer of crushed stone over them, there is a solidified area of ground with increased bearing capacity sufficient to carry the loads.

It is not difficult to determine on the bearing capacity of an area of this kind: simply drive piles until you cannot get any more in. In some cases it may be necessary to pile outside the actual area over which the concrete rests in order to obtain a thoroughly safe condition.

Structural Steel Subway.—We have also built a rather different type of structural steel subway. This subway consists of two structural steel plate girders with steel floor beams between them spaced at about 11-ft. intervals. Instead of the usual steel stringers filled with concrete we have substituted a T-section of reinforced concrete, on which the rail has been directly laid in a groove

ada and the States. I have taken the actual cost of these structures as built and made a comparison of what they would have cost if a really economical design of either a concrete or steel structure had been made, and find the startling fact that about 40 per cent of the cost of these structures could have been saved and a better structure obtained.

In making these comparisons I used the same unit prices as were actually paid for concrete, structural steel, reinforcement, excavation, etc. As a result of these comparisons I have no hesitation in saying that there are tremendous amounts of money wasted all over the country in the designing of grade separation work. A lot of engineers have been doing some careful work towards eliminating this waste, but there are still many wasteful structures being built both in Canada and the States.

If the cost of grade separation structures could be cut down by about 40 per cent, it would probably result in much more of this type of work being done as an unemployment relief measure, that is, the lower the cost the more likely the Governments would be to undertake work.

In developing the various types of structures, the Bridge Department was allowed perfect freedom and given every assistance by C. B. Brown, chief engineer of the Canadian National Railway System, T. T. Irving, chief engineer of the Central Region, and W. A. Kingsland, general manager, Central Region, these gentlemen's positions making them particularly interested in these developments.

What Shall We Do With the Lower Than Cost Bid?

By R. E. O'Connor

Director, Indiana Highway Constructors, Inc., Fort Wayne, Ind.

IN our study of the question of what we need in order to enable our industry and particularly the highway division to carry on as it must, we have come to one conclusion. We have decided that there is one right we must have, and were all others denied us, this alone would enable us to function as we should to govern ourselves, to protect others, and comply with all our obligations.

We are so certain of our position that we would be ready to waive all else in our code, to let anyone write it, as long as we can be secure in this one provision, which the committee asked for on Dec. 14, after having reviewed the tentative draft of Chapter Two, General Contractors' Code, dated Dec. 9, 1933. Approval of said draft was given by the committee subject to inclusion in it of the following:

"It may prescribe bidding rules, requiring the inclusion in each bid of all direct and indirect costs, properly defined, and method for administering such rules, and the same when approved by the administrator shall apply to the respective sub-division proposing the rules."

In this we have what we must obtain, a control of the lower-than-cost bids and the means to determine it. The control of our industry will center in the policing of such bids.

We can under this provision compel the bids to be based on a cost that takes into consideration the actual costs involved, not those seen or determined by any individual, but as reflected in the industry as a whole. We would therefore actually bid the job, not against our competition on it.

We Recognize No Dividing Line to Exist Between Them.—Our subject says Lower Than Costs Bids, nothing about profit. Code provisions say below costs in the industry, which cost is to be determined by a survey of the costs of all manufacturers in the industry and must therefore include the most efficient as well as the most inefficient in its scope. The resulting cost of production being not an average cost but a figure that will fall somewhere below the average, depending upon the ratio that exists between the number of efficient and the inefficient plants, the producing capacity of these plants and other factors.

This cost of production, therefore, when determined, will be higher than the cost of production of the most efficient plants and lower than that of the inefficient ones. This will permit the efficient plants to sell at the cost of production so established and in such sales they will have an item of profit included.

As a result of this fact, it becomes necessary for all those plants whose cost of production is above the cost established to take such action as will enable them to compete. This action can follow but one course. They must reduce their costs by increased efficiency, quality and service, and in accomplishing this under some codes they must do so without increasing production, or enlargement of plants, unless permission is obtained so to do through the code authority. In some codes, provision is also made for an allocation of business.

It is well to mention here that code restrictions do not in any instance bar price competition; they merely set up rules to establish it.

Neither do they in any manner guarantee a profit to industry, though they do provide the methods by which it can be obtained. Industry must bargain collectively, and applying the code provisions to their affairs, solve that for themselves.

The industries write their codes, not the administrator, for he is responsible for only that part which is included to set out the rights of the public, of labor, and all others as provided by the law and to protect them, and to act as a friendly judge to see that industry does deal fairly with its members.

We must look upon this question in a broader and wider viewpoint than has prompted our thoughts and desires through the years that have gone. We have been very local in our ideas; this we have exemplified in our actions in business and towards our government.

We have thought as individuals, acted as such, and split ourselves asunder, forgetting all else but self in our rush for gain. It has taken some terrible happening to stop and awaken us for short periods in our history, after which we resume our way only to create a worse mess than that from which we have just escaped.

Our actions have finally landed us in the worst smash-up that any nation ever experienced. May we now look upon the cleaning up of the wreckage and pledge ourselves in collective action to help in rebuilding the structure and to remove for all time the causes of the failure.

This is inserted here because we must now face a situation that must be met and defeated if the proper results are obtained from the Recovery Program.

Let us consider the attitude of the public and their agent, the public official, who are the consumers to whom we must sell our production. They are among those referred to as we and ourselves in what has just been said, and they must also take the pledge and in taking it must see the need for such action.

The public have seen this need and no one can deny that their support has been given to the program of recovery. We must go further and protect them fully and well to justify them in their position.

What about their agent, the public official? We must recognize that they are in a position wherein their actions cannot in the whole reflect what it may be their desire to do, since they are governed in large part by statute.

However, they are in their official capacity bound to public service for the good of the public, and acting as their agent cannot in justice to this employer do other than recognize the responsibility that rests on their shoulders to assist in every way possible in furthering the cause of Recovery.

In the viewpoint of these officials the word Economy, which we use so often, has great importance as it rightfully should, but we contend that their definition of it often fails to recognize the true meaning of the word as it is used in connection with the National Industrial Recovery Act, for there it has been shown that Economy

in first cost may in many ways result in very expensive buying.

"Experience has taught us that if we want a thing cheap, we must pay for it dearly." We ask public officials to recognize the fact that through operation under codes there will result an actual reduction of cost. This reduction may not be seen in dollars and cents for products may cost more, but if we are sound in what we aim to do, it will show up in the values attained by a recovery in industry, in employment, increasing purchasing power, in property values and in all other things necessary for recovery, not the least of which is peace and happiness to our people.

We wish to cite the expenditure of money under CWA as an example. Who of us could contend that in any way such expenditure can be measured or justified on the economy of a dollar expended, or being awake to the need, attempt to justify it on that basis. No man can say the actual values it saved us, nor question what it may have saved us from.

Our government recognizing all this has provided that the purchase of materials and supplies for all work in which government money is spent shall be made from industries operating under codes of fair competition.

In this, of course, it leads the way, knowing the old truth: A house divided against itself shall fall. This policy should be followed by the states, the counties, and cities and all divisions of government; yes, and by the citizens thereof; or the house is still divided.

Certain states have already realized the importance of this and have taken action by writing into their laws a Recovery Act or State Code in order to fully comply with their obligation.

We must take the position that the public official should not be given the duty of policing codes for industry; these are the plain duty of the industries themselves. We do, however, ask their full cooperation in this as well as in solving our method for control of costs of production to be provided for in the highway divisions rules and regulations under Chapter 2 of the General Contractors' Code.

We know the position they hold enables them to do so and have faith in their willingness to assist us.

The Plan for Controlling Lower Than Cost Bids.—Our plan has been developed after many trials. We now present it to you as a suggestion of the method by which we can exercise through a control of bids; a control of lower than cost selling in highway work. We do not say the plan is the ultimate plan; it will we hope lead to that determination. We welcome criticism of it to bring about that result.

We determine lower than cost bids by establishing from all bids actually received on a project the average bid, then adding it to all bids below this average bid, we strike an average, which we call the average of the average bid and the bids below. Under this plan, the award will be made to the bid filed that is either closest above or below or equals this figure.

Why have we taken this means to arrive at a solution of our problem when we have already mentioned the provision for determination of cost of production in the highway industry? We recognize the conditions that enter into our case, and try to meet them. We know the trouble ahead of us in determining this cost of production of the products manufactured by the contractor. We realize the variables which enter into such production costs from project to project, and for the time-being abandon their determination as being next to impossible by a cost examination of all the industry or by records in a manner that would be satisfactory without great question of doubt, on account of this variation having to be considered.

We apply to the problem our plan to establish this cost and yet retain the same reasonable profit item for efficient operation by using the actual selling price of the products of the industry as reflected in bona fide quotations or bids submitted for their sale.

We know that most of these bids or selling prices have been below the production cost of the products as reflected in the industry as a whole, and that they do not cover this cost. Though contention might be made on this by the uninformed, it in no wise destroys the fact that they are below the average cost, judged by the average cost bid by other contractors or manufacturers in the industry, which is in itself contrary to provisions in the codes.

In addition, these low bids do not reflect the item of reasonable profit that must enter into the rehabilitation of industry as profit cannot be present until all cost is covered.

We do not destroy competition, for we do nothing to competitive conditions except as provided by the codes. We do destroy the incentive of the bidder to be low and remove the condition that requires him to so be, in order to secure a contract.

In this plan we fix the control of the buyer in his purchases, to a greater degree than before, and enable him to take a real part in the recovery program without great increase in cost. The plan follows closely the thought that if it is reasonable to have the state or awarding body fix a maximum estimate, above which no award will be made, it is just as reasonable and much fairer that they should by the same reasoning have a minimum estimate below which they would make no award. The importance of this being plain, as it would carry out the thought of protection to the public interest completely rather than in part.

No one can question the soundness of this statement in the light of what has been developed in the awarding of public work. This has shown that the loss to the public, and to industry, and to labor resulting from awards on bids below actual cost can result in as great or greater loss than that occasioned by an award at fair and reasonable prices, which do at least reflect cost.

There is no problem involved in the determination of a minimum estimate, for that must be determined before the maximum estimate can be arrived at. The maximum estimate, if it has any claim for existing as such, must include an item of reasonable profit and profit cannot be figured until costs are completely covered.

Our plan would direct more attention to the figuring of proper estimates of such cost, and as we, an industry through our code authority, could assist the public official in methods and means to that end, acting fairly with them and the public in so doing.

The problem is not a complex one as data can be used from records and proofs beyond question, positive information that is available.

The plan will result in reduced costs, real economy based on the proper definition of the word and in its true meaning. It will enable us as highway contractors to do our full part and to accept our obligation as we should as members of the highway division of the construction industry in the national program for recovery.

We can defend this plan and that is our reason for endorsing it. All the defense cannot be made here. We acknowledge that it is revolutionary in character in that it is contrary to any plan used by awarding officials in the award of public or private work. It is revolutionary in that it takes away from a bidder the incentive to be low at any cost, and is further revolutionary in that the

EXHIBIT A

APPLICATION OF PLAN TO INDIANA PROJECTS.
BIDS ALREADY RECEIVED.
F.A. PROJECT

Number of bids = 5
Engineer's estimate = $35,402.51

Bids:	
$ 29,419.30	
29,861.32	
29,897.68	
30,807.41	Average Bid = 151,198.13 / 5 = $30,239.62
31,212.42	
$151,198.13	

Average Bid + bids below average:

(A)	$ 30,239.62	
(B)	29,897.68	
(C)	29,861.32	Average of Average Bid and bids below = 119,419.92 / 4 = $29,854.98 (1)
(D)	29,419.30	
	$119,419.92	

Contract would be let to (C) as being nearest to (1).

Number of bids below the average of the average bid and bids below = 1, above = 2.

Per cent of increase over the lowest bid = 1.5%.

Note: This is the lowest per cent of increase in 25 trial tests applied to actual bids on 1933 projects.

EXHIBIT B

APPLICATION OF PLAN TO INDIANA PROJECT.
BIDS ALREADY RECEIVED.
P.W.A. PROJECT

15 bids received on concrete pavement

Bids:	
$ 265,566.07	
270,314.64	
270,832.64	
287,354.39	Bids below average bid = 9, above = 6
292,813.33	
292,920.07	Average of average bid and bids below =
295,709.68	$286,876.61
297,035.94	Bids below = 3, above = 6
297,850.84	
311,586.24	Increase over low bid = 8%+
312,132.37	
315,337.78	
317,147.52	
321,498.38	Average bid = 4,475,528.03 / 15 = $298,368.52
327,428.14	
$4,475,528.03	

2 bids received on asphaltic macadam pavement

Bids:	
$287,707.77	
288,556.41	Average Bid = 576,264.18 / 2 = $288,132.09
$576,264.18	

Average of Average Bid and bids below average = $287,985.97.

Increased by 8%+ (to compare with concrete bids) = $311,024.84.

Engineer's estimate on concrete = $329,157.44.

Engineer's estimate on asphaltic macadam = $371,915.37.

Note: This represents the highest per cent of increase in 25 trial tests on actual bids received on projects during 1933.

unbridled, unrestrained competition, which has hitherto existed, would be effectively checked, although true competitive bidding in itself would in no wise be limited.

Notwithstanding these revolutionary aspects, it might well be cited that this plan is no more revolutionary than the National Industrial Recovery Act itself, for in that, it has been conceived. Any proposal of it prior to the advent of that law would have caused it to be rejected and discarded unceremoniously on the ground that it was without precedent and contrary to all existent interpretations of statutory provisions concerning the award of contracts.

We must repeat that the application of a code clause for determining costs of production in the highway industry is not as simple as it may seem, for we have many points to consider in that application.

It does prompt the question, What is our production? We contend that it is the project to be built. While we do manufacture units to enter into it, their cost of production is only a part of the costs of the whole, which constitutes our actual and final production. This is as true in this instance as in the production of a machine or any structure by any other manufacturer.

Recognition of this does not mean that we can ignore units in our determination. It is automatically handled in our plan, for in it by control of lower than cost bids, we do take care of that factor.

We base our whole case upon the theory that a competent bid, including all costs must include all costs and is of as much value to the public and their agent the awarding body, as it is to the construction industry itself.

We know contention will be made by some that this plan would be in violation of our state statutes, which provide for the award of contract to the "lowest and/or best bidder." Our reply to this contention would be that the competency, or adequacy, of a bid is as important a factor in determining "the lowest and/or best bidder" as would the bidder's financial standing, equipment holdings, or experience.

If the competency, or adequacy, of a bid, at which a given project is to be done, can be predetermined or definitely assured by any plan that may be devised, surely it logically and consistently becomes an important factor in what shall constitute the "lowest and/or best bidder."

Through the appreciation of this and its application to all bids, we will be able to carry out the obligation resting upon all of us and assist in the program of national recovery. In so doing, we must remember that our responsibilities in the future will include not merely the custody of our own fortunes, but the welfare of our industry and the welfare of our country.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 20th Annual Purdue Road School.

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M. L. Enger Now Dean of College of Engineering, University of Illinois

Professor Melvin L. Enger, a member of the University of Illinois faculty since 1907 and head of its department of Theoretical and Applied Mechanics since 1926, has been named dean of the College of Engineering and Director of the Engineering Experiment Station of the University, by the Board of Trustees. Arthur Cutts Willard, who was elected president of the University, has been serving as Acting Dean of the College of Engineering this year. To fill the vacancy caused by the election to deanship of Enger, Prof. Fred B. Seely, a member of the faculty since 1909, was named the Theoretical and Applied Mechanics Department head. Another vacancy, caused when president-elect Willard was promoted last fall to the engineering deanship, was also filled by the Board when it named Prof. O. A. Leutwiler to head the Department of Mechanical Engineering. Willard was for years head of that division. Leutwiler has been a member of the engineering faculty since 1903 and has been professor of mechanical engineering since 1921. All three of the new appointees hold degrees from the University of Illinois. All will assume their new duties July 1. Dr. R. D. Carmichael, who has acted as dean of the Graduate School during the present year, and Dr. M. T. McClure who has served as acting dean of the College of Liberal Arts and Sciences for the same period, were both promoted by the Board to full deanships.

EDITORIALS

Highway Robbery

UNDER a law just passed in Illinois one-third of the gasoline tax will be diverted to school use. This law might well be called an act to effect highway robbery for the benefit of teachers. What it does in fact is to deprive highway workers of jobs so that public school teachers may be paid salaries several fold greater than existed prior to the world war.

These teachers have exerted political pressure upon the governor and the legislators and, because of their organized effort, the state of Illinois is about to abandon a substantial part of its highway program. There are more than 10,000 Illinois schools that have only one teacher. This inefficient and extravagant condition exists mainly because of the lack of surfaced roads over which school buses can travel rapidly in bad weather. Improvement of the secondary highways is badly needed not only for the reason just given but for the benefit of rural and small town residents. There is no denying the economic need of continuing the improvement and maintenance of Illinois highways without diverting a single dollar of the gasoline tax.

Gasoline taxes are tolls levied for the construction and repair of highways.

Motorists have willingly submitted to such tolls because of the need of pulling Illinois out of the mud. Because real estate taxpayers have become delinquent and because politicians have not had the courage to make more drastic cuts in school expenditures, many Illinois teachers have gone without salaries for months. But that furnishes no excuse for robbing the highway funds and throwing thousands of highway workers out of jobs.

Isn't it about time that highway workers were organized for self-protection? The average politician seems to listen only to the voice of organized groups of voters.

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Some Criticisms of the Highway Code

CHAPTER I of the code for the construction industry was published in the March issue of ROADS AND STREETS. In the present issue will be found the proposed Chapter II-C of the code that is to govern highway contractors.

This proposed highway code contains several sections that are very objectionable. Section 1 of Article V prohibits a contractor from securing financial aid from a sub-contractor, a surety company or a material vendor. It prohibits his subletting more than 20 per cent of the total value of the contract, "exclusive of items not commonly found in contracts for similar work."

The obvious object of these provisions is to shut out contractors whose financial resources are relatively small. We object to that.

One of our readers has criticised the code on the ground that "it gives the Associated General Contractors of America a strangle hold on the construction industry." He objects to "the attempt to put this code through on the quiet." It seems to us that before any code is put into effect, it should be given the widest publicity, and that criticisms from all members of the industry should be invited. In this particular case the editors of ROADS AND STREETS would not have received a copy of the proposed highway code had not a photostat copy been sent to us by one of our Washington subscribers. Certainly the charge seems to be well founded that this code is being put through "on the quiet."

Section 3 of Article V reads: "Any Highway Contractor renting or leasing equipment shall do so under rental schedules prescribed by the State Committee."

This is an ambiguous sentence, for it may mean either that the Highway Contractor is a lessor or a lessee. Which? But we object to it primarily not because of its abiguity but because of the "price fixing" that it aims to effect. To begin with, no rental schedule that has yet been published has much significance because such schedules invariably fail to specify the mechanical condition and the economic efficiency of the equipment. And we challenge any one to write such a specification that will be fair to all types and conditions of second-hand equipment.

More important than this objection is the fundamental objection to price fixing. If the rental price for second-hand equipment is to be fixed by a State Committee, why not let that committee fix the selling price of new equipment?

We contend that no man or group of men, whether public servants or members of a Code Authority, should be given price regulating powers.

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The "Planned Economy"

OUR agricultural department has induced cotton farmers and some other farmers to adopt the quota system of production. Under such a system each farmer is to be allotted a certain acreage that is to be used for a given kind of crop. The object is to produce a total crop that will just meet the normal demand. Enough consideration has not been given to the effect of weather variations on crops. In assigning quotas, a normal or average crop must be assumed, for otherwise the total production may either exceed or fall short of the normal demand. But weather never is normal. A succession of dry years will completely upset the plans of the ablest of agricultural planners. What then?

Quotas of industrial production are not subject to weather variations, but they are subject to changes in demand for the product. There is scarcely an industrial product that does not have a competing product. Since not more than 25 per cent of all that we consume is an absolute necessity, it follows that the sale of the "luxuries" or the remaining 75 per cent, is dependent upon a demand that is susceptible of great variation. Let the price of a "luxury" be suddenly raised, and its sale declines. What, then, becomes of a planned economy based upon quotas as to the production of "luxuries"? The planners have apparently assumed that practically all "goods" are necessities, when very few of them are. In order to remedy this oversight the planners will presently undertake to regulate prices. That will lead to battles not merely within each industry but between competing industries. Since nearly all industries compete for "their share of the family budget," there will be a political "battle royal" if government price regulation becomes common.

Had the quota system been in existence when Ford first introduced his mass system of automobile production, not only would there be far fewer cars today but their prices would be far higher. In that case highway improvement would have lagged, and the outlook for future improvement would be poor indeed.

This quota business is your business, whatever your job may be. Government planning is not the solution of the business cycle problem, nor does it survey the highway to Utopia.

County and Township Roads

A Section Devoted to the Interests of Those Responsible for Secondary Road Improvement

Methods and Costs of Stabilizing Gravel Roads in a Michigan County

By WALTER O. DOW

County Engineer, Grand Traverse County, Traverse City, Michigan

GRAND TRAVERSE County is located in the northwestern corner of Michigan, in the center of the summer resort region. Because of this fact, our roads, in summer, carry from two to three times

Fig. 1.—Digging Clay from Pit

the normal traffic. The type of people involved in this summer traffic expect and demand a smooth, dustless road surface.

It has taxed our resources to the limit to maintain such a standard on gravel roads under summer traffic conditions. The county now maintains approximately 350 miles of this type. Because of the sandy nature of the material which is locally available, these have been covered usually with loose gravel, and have required blading several times a week during the summer months in order to give even reasonable service to the traveling public. Such frequent maintenance has been expensive, yet replacement by a hard surface type has been out of the question because of the large investment of funds necessary. We have been eager, therefore, to find a type of surface which could be built at reasonable cost and which would remain smooth and dustless with low maintenance costs.

Fig. 2.—Loose Clay on Center of Road

When the new stabilized gravel type of surface was called to our attention, we made a trip to Midland County, Michigan, and inspected several experimental roads of this type. After studying the theories involved in the stabilization of loose gravel by the addition of clay and subsequent application of calcium chloride, and after seeing the results that were being obtained, we were convinced that this type of improvement was well worth trying.

Our first project was undertaken on two miles of loose gravel road during the month of October, 1932. The excellent condition of this road during the spring months

Fig. 3.—Crushing Clay with Gravel Roller

which followed convinced us of the merits of the stabilization methods and a number of other jobs were undertaken during 1933.

Preliminary Operations.—In common with any type of surface, a stabilized gravel road requires proper drainage so as to quickly remove rainfall from the surface and the subgrade. Side ditches must be provided and in some cases tile under-drains are desirable. The road gravel on each of the projects was sampled at sufficient intervals to indicate the grading and uniformity of the material. At each sampling station, holes were dug into the road on the center line and about 5 ft. each side of the center. Ordinarily, these holes were dug to a depth of 3 in., and the materials from the three points at each station were assembled into a composite sample which was used in the laboratory tests. Samples of clay de-

posits in various parts of the county were also obtained. These were tested in order to indicate the best quality of binder material and to locate the most economically situated sources for use on the roads.

At this point, I wish to acknowledge the assistance and cooperation which we have received from The Dow Chemical Company. As part of the service of their Soil Stabilization Department, they secured the necessary samples of materials, conducted the laboratory tests, and on the first couple of jobs they provided a field engineer to assist us.

All our roads which have been stabilized thus far have originally lacked cohesive material. While clay is well distributed in the county, most of the road grades and gravel pits are sandy. Tests, involving those portions of the gravel samples which passed the No. 40 sieve, and the similar fractions of nearby clays, were made in the laboratory. The results were used to determine the proportion of clay which should be incorporated with the gravel on each job in order to provide a stable wearing course. In general, it was attempted to provide for a 3-in. mat which would have plasticity index between 5 and 10. The laboratory reports indicated the quantities of definite clays which should be delivered per 100 ft. of each road which was being stabilized.

Clay Delivery.—The clay was dug from the pits with a power shovel and hauled to the jobs in 1½ cu. yd. dump trucks. Figure 1 shows the digging of clay for the Acme-Kalkaska County Line job. Before spreading the clay, the loose gravel was bladed to the center of the

Fig. 4.—Loose Clay After Partial Crushing

road and the clay was deposited thereon. The loose material under the clay prevented the latter from sticking to the road. If the clay was reasonably dry as it came from the pit, it was immediately broken up by running a gravel roller over it, followed by a spring-tooth harrow. This accelerated the removal of the remainder of the moisture from the clay and also aided in crushing it. A view of loose clay on the Garfield Road is shown in Fig. 2. The crushing procedure with the roller is shown in Fig. 3, while clay after this operation appears in Fig. 4.

When the clay, as delivered on the job, was too damp for immediate crushing as described above, it was bladed, together with the loose gravel, into windrows on each side of the road. There, drying took place, after which the mixture was returned to the road for crushing by the roller. Motor grader and truck blades were also used to work the clay and loose gravel back and forth on the road surface to aid in drying and pulverizing it. When this was accomplished, the mixture was bladed into windrows on the shoulders to await the next operation. The blading of the mixture of loose gravel and clay to the shoulders is shown in Fig. 5 and the resulting windrows appear in Fig. 6.

Scarifying.—The mixture of dry, pulverized clay and loose material was bladed uniformly over the surface of the road. This was followed by scarifying to the desired

Fig. 5.—Blading Loose Gravel and Clay to Shoulders

depth which was usually sufficient to give a total of 4-in. of loose material, or 3-in. when compacted. A York rake, pulled by a 5-ton truck, was used in scarifying some of the jobs, while a motor grader, with a 20 hp. tractor aiding it, was used on others.

Mixing and Removal of Oversize Stones.—After the old compacted road surface had been loosened to the desired depth, the York rake was again drawn over the road using both the blades and the rake to mix the loose materials. The motor grader was next used to split the mixture of clay and scarified material out from the center of the road and to blade it back and forth, making sure that the mixture was turned over completely several times. This thoroughly mixed the fine and coarse constituents and also improved the cross-section of the road. A multiple blade maintainer is also used for mixing.

When the old road contained an appreciable quantity of oversize stones, an extra trip or two of the York rake after the mixing operation served to bring them to the side of the road. Following this operation, on some projects, the motor grader made a trip on the sides with the outer end of blade raised. This assisted very much

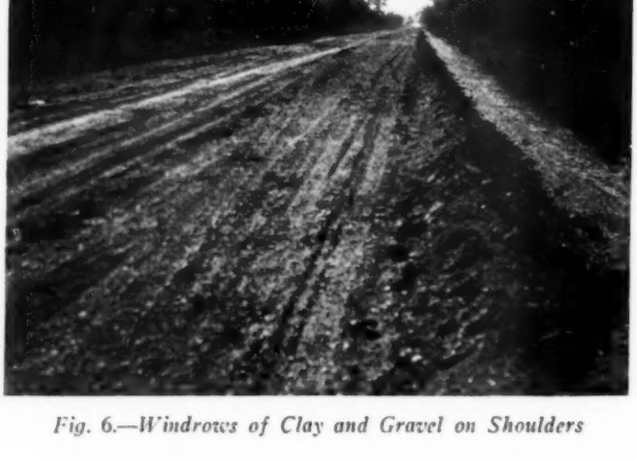

Fig. 6.—Windrows of Clay and Gravel on Shoulders

Fig. 7.—View of Stabilized Section of County Line Road

in delivering the large stones to the shoulders from which they were forked into trucks and hauled away.

Shaping and Compacting.—On all but the last project, it was customary to shape up the finished mixture to a crown of ½ to ¾ in. per foot and then to treat with calcium chloride. This latter operation was done during the late afternoon of the day on which the mixing was completed or early the next morning. The calcium chloride would attract moisture and thus aid in compacting the road as well as making it dustless. On some of the jobs, however, where there were several inches of loose material, a very damp crust would remain soft and unstable until after a rain occurred. This made it difficult to obtain a smooth and satisfactorily shaped road until some time after the construction work was completed.

This trouble was completely eliminated on the last two projects by introducing water from a sprinkling wagon during the shaping and compacting processes. All the loose material was windrowed to the sides of the road and the old compacted base was dampened with water. About one-fourth of the loose mixture on the shoulders was then immediately bladed over the whole road surface. Subsequent applications of water were made, followed in each case by layers of loose mixture until the latter was all on the road. The desired crown of the road was gradually built up as the sand-clay-gravel mixture was brought in from the shoulders. Traffic, of course, assisted in compacting the road. On the following morning, the road was again sprinkled and shaped. In this final shaping, the blade on the truck was set with very light pressure and the truck was operated at a relatively fast speed. This left the surface of the road in the best possible condition and calcium chloride was then applied at the rate of 2 or 3 tons per mile.

The procedure just described, of intermittently applying water to the mixture of sand, clay, and gravel as the materials were bladed onto the road for final compaction, was found to be the best method for the final stage of the stabilization process. By adding the water, first at the bottom and then to succeeding layers, a firm, finished road was immediately produced. Even when a heavy rain occurred a few hours after a section of road had been completed by this method, no appreciable softening of the road took place as the water was shed almost completely.

TABLE I—STABILIZATION COSTS PER MILE OF GRAVEL ROAD, GRAND TRAVERSE COUNTY, MICHIGAN

	Garfield 2 mi.	County Line 3 mi.	Acme-Kalkaska 8.63 mi.	Silver Lake 5.5 mi.	Secore 2 mi.	Average
Clay, in pit (10c per cu. yd.)	$ 15.60	$ 9.00	$ 18.80	$ 26.00	$ 28.50	$ 22.25*
Loading clay	46.85	12.55	22.40	36.25	34.44	34.98*
Hauling clay	98.40	20.73	57.60	65.70	57.90	69.90*
Spreading clay	12.15	8.15	10.10	16.50	9.73	12.12*
Pulverizing clay	11.10	10.76	7.82	12.20	10.50	10.48
Scarifying, mixing and shaping	62.52	33.86	24.00	53.10	41.06	42.91
Stone removal.				8.60	36.45	
Sprinkling				33 00	34.10	33.55
Calcium chloride (applied)		58.51	46.30	44.20	48.75	49.44
Total per mile.	$246.62	$153.56	$187.02	$295.55	$301.53	$275.63**

*Costs from County Line project omitted because thickness of stabilized course was only 1.5 in.; other projects were 3 in.

**Average, exclusive of cost of removal of stone. Width of stabilized wearing course was 20 ft. on all projects.

Cost Data.—An itemized account of costs was kept for each project and is listed in Table I.

Maintenance.—The amount, and hence the cost, of maintenance for stabilized gravel roads is much less than for the ordinary type. It is very important, however, that stabilized gravel be maintained at the proper time. Skill and experience in these operations are also very necessary.

Ordinary maintenance consists of patching, blading, and light applications of calcium chloride. After long intervals of dry weather, pit holes are liable to develop, particularly if the calcium chloride treatment has been delayed too long. These are patched with a mixture of clay, gravel, and calcium chloride, as near like the original preparation as possible. Gravel passing a ½ in. screen is preferred for this purpose. The pit hole is wet from an ordinary sprinkling can, the mixture is tamped into the hole with a shovel and leveled with the surrounding surface, and then a light layer of calcium chloride is sprinkled over the patch.

Blading can be done only after a rain because in dry weather a blade will not cut the surface. Truck blades

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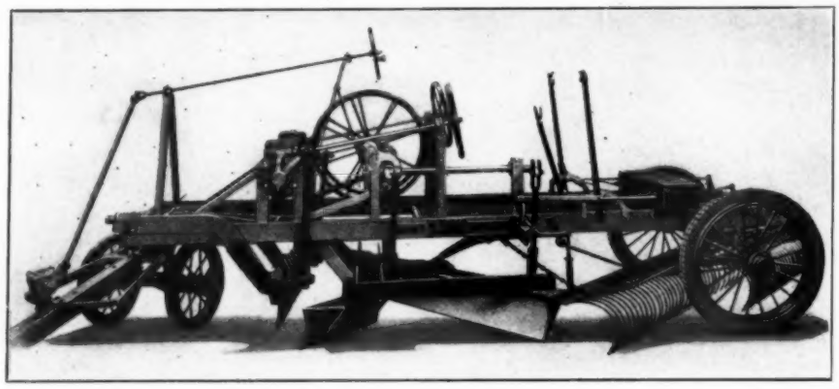

THREE WORKING UNITS — Scarifier, Blade, Rake—THREE TYPES OF WORK — Digging, Cutting, Raking—ONE OPERATION—ONE MACHINE . . . The YORK SUPER WORKMAN . . .

This combination is unique in the field of road machinery . . . **AND** . . . It is practical—It is soundly engineered—Its maker has specialized in "Road machines with rakes" for over a decade—It is endorsed by owners of hundreds of machines in operation today . . .

The **Scarifier** is unusually effective, capable of digging up any road from dirt to macadam. The **Blades** make a most satisfactory cut, true, even and smooth. The **Rake** mixes and distributes loosened material, screening out oversize stones . . .

The SUPER WORKMAN is unequaled in maintaining and rebuilding dirt, gravel, crushed stone and macadam roads; it is indispensable in stabilization projects; it is an efficient machine in retread and black-top work.

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and motor graders are used for this purpose. Experience will teach the operator just the proper time after a rain to begin blading. Working too early will result in tearing the surface, while if the shaping is started too late, the surface will begin to harden and cannot be cut.

During the first season, slippery spots may develop after a hard rain, due to the fact that it is difficult to maintain laboratory proportions of clay, sand, and gravel in the field. A light coat of pea gravel of coarse sand sprinkled over the places will correct this condition.

Our maintenance costs are kept by sections. Since our Acme-Williamsburg road was the only project where a complete maintenance section was stabilized, it is the only project where our costs can be compared with the costs on the original road. On this section, we were compelled to blade the old gravel six times a week during July and August. After stabilization, the road was kept in much better condition and required blading only seven times in July and four times in August.

Our plans for the coming season call for the construction of 20 miles of stabilized gravel. The economy which is effected by this type of road lies chiefly in two directions: first, the scraping maintenance is less; and second, the loss of materials from the road, and hence the quantity of replacement gravel, is reduced considerably.

Another advantage of stabilization is the increased benefit that is obtained from the use of calcium chloride on surfaces of this type. By using three or four light treatments ranging from one to two tons per mile each, continuous dustlessness can be secured throughout the season at a low cost.

Acknowledgment—The foregoing is an abstract of a paper presented at the 20th annual Purdue Road School.

China Forges Ahead in Highway Improvements

Road construction continues to hold a dominant position in the activities of the National Economic Council of China, according to a report from U. S. Commercial Attache Julean Arnold, Shanghai, to the Automotive Trade Division of the U. S. Bureau of Foreign and Domestic Commerce. The Bureau of Public Roads announces that 2,537 miles of surfaced roads and 3,933 miles of earth roads have been opened to traffic since inception in June, 1932. At the present time 1,163 miles of highways are in the course of construction in the seven provinces of Central China with an additional 6,410 miles projected. Plans have recently been mapped for the construction of a network of highways in the three northwestern provinces of Kansu, Shensi and Sinkiang which will involve approximately 9,000 miles at an estimated cost of Chinese yuan 22,000,000. An important 42 mile branch line connecting Wusih, an important Chinese industrial center on the Shanghai-Nanking Railway line, with Ishing, a point on the Inter-Provincial Highway was opened to traffic on March 10. This gives connecting motor transport between this industrial area and the national capital at Nanking, as well as with Hangchow, the provincial capital of Chekiang. It is the first section of the branch line that will ultimately connect Shanghai with the Inter-Provincial trunk highway leading to Nanking.

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CONFERENCE ON STREET AND HIGHWAY SAFETY.—The 4th national conference on Street and Highway Safety will be held May 23-25 in Washington, D. C. A. W. Koehler, 1615 H St., N. W., Washington, D. C., is Secretary.

Methods of Preventing *Frost Heaves in Highways*

TO correlate the various methods employed by different engineers for the prevention of the harmful effects of frost action, the U. S. Bureau of Public Roads with the cooperation of the highway departments of Minnesota, Wisconsin and Michigan conducted a survey during the period from 1928 to 1933. A report, the results of observations by its author, Henry Aaron, Assistant Highway Engineer of the Division of Tests of the Bureau, supplemented by information from engineer and maintenance superintendents from the above states, appears in the March issue of Public Roads. The report is intended primarily as an exposition of methods used to prevent harmful frost action and the result of these methods. It contains so much useful information that the matter following has been abstracted from it:

Figure 1 shows the different types of soil profiles in which the preventive measures described in the report were installed.

Preventive Measures.—Various methods used by different engineers in efforts to prevent frost heaving are shown in Fig. 2. Considering only the locations inspected in this survey, Fig. 2-*A* shows a method which has been used since 1921; figures 6-*B*, *C*, and *D* since 1928; figures 6-*E*, *F*. *G*, *H*, *I* and *J* since 1929; and Fig. 2-*K* to 2-*P* inclusive since about 1920.

The methods of excavating heaving soil and substituting a non-heaving material are illustrated in Fig. 2-*A* to 6-*I* inclusive.

Fig. 2-*J* shows excavation of the heaving soil, treating the bottom of the excavation with bituminous material to cut off capillary action and replacing the excavated material.

Drainage channels to intercept and direct water away from the roadbed are shown in Figs. 2-*K* to 2-*P* inclusive.

Generally no more than 2 years are required for the surface condition to reflect the effectiveness of the preventive method used. This is especially true of methods which do not serve the requirements of the location. In such cases heaving has been observed during the first winter after installation. Therefore, the results of methods which have been in service since 1929 are considered fully as significant as those which have been in service since 1920.

Results of Preventive Measures.—The performance of these preventive measures employed in connection with different types of road surfaces and the associated local soil condition is described in Table I.

The narrow center trench Types *A*, *B*, and *C*, serves to eliminate only that heaving which might occur directly

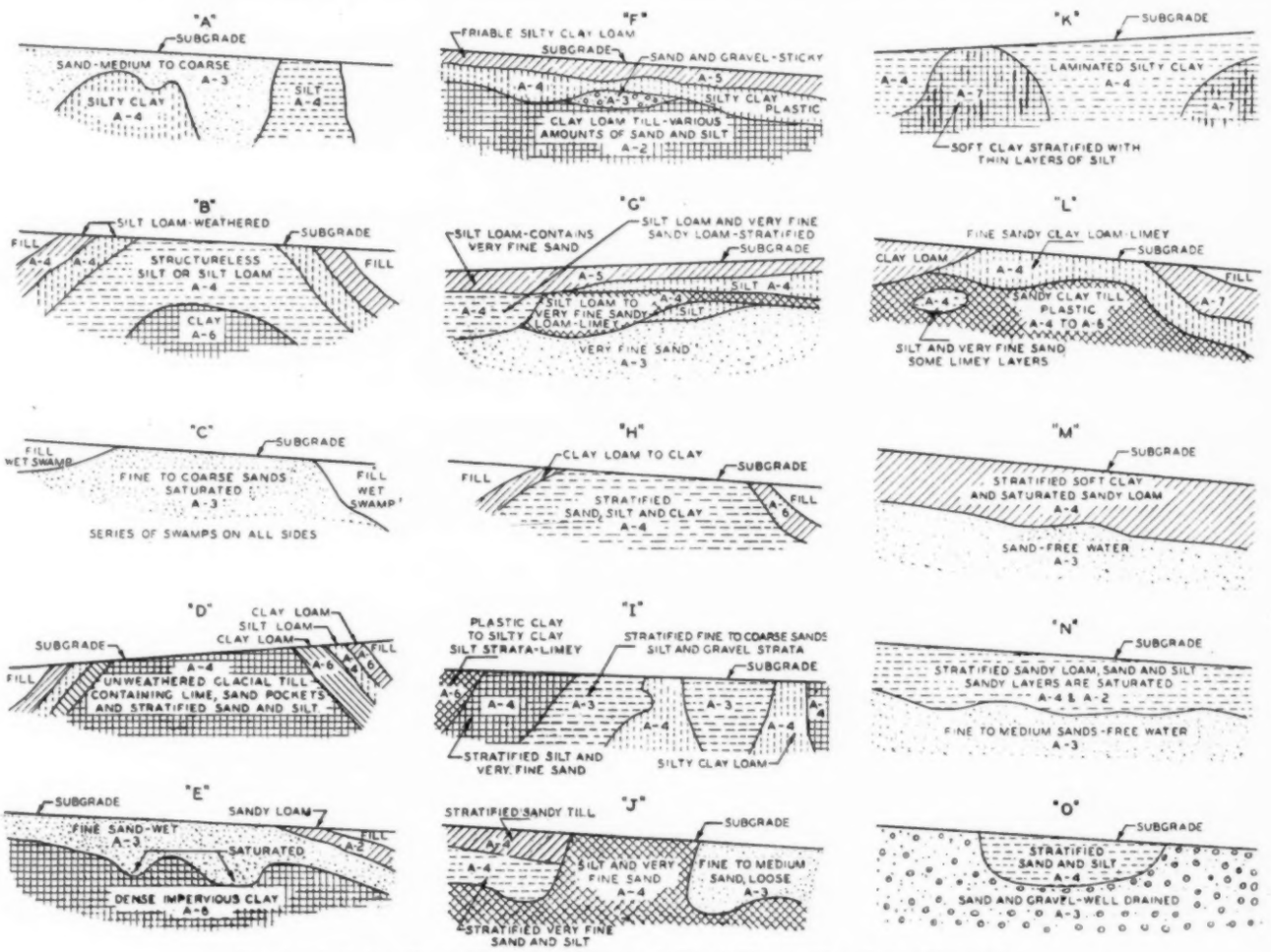

Fig 1.—Soil Profile in Which Detrimental Frost Heave Has Been Observed

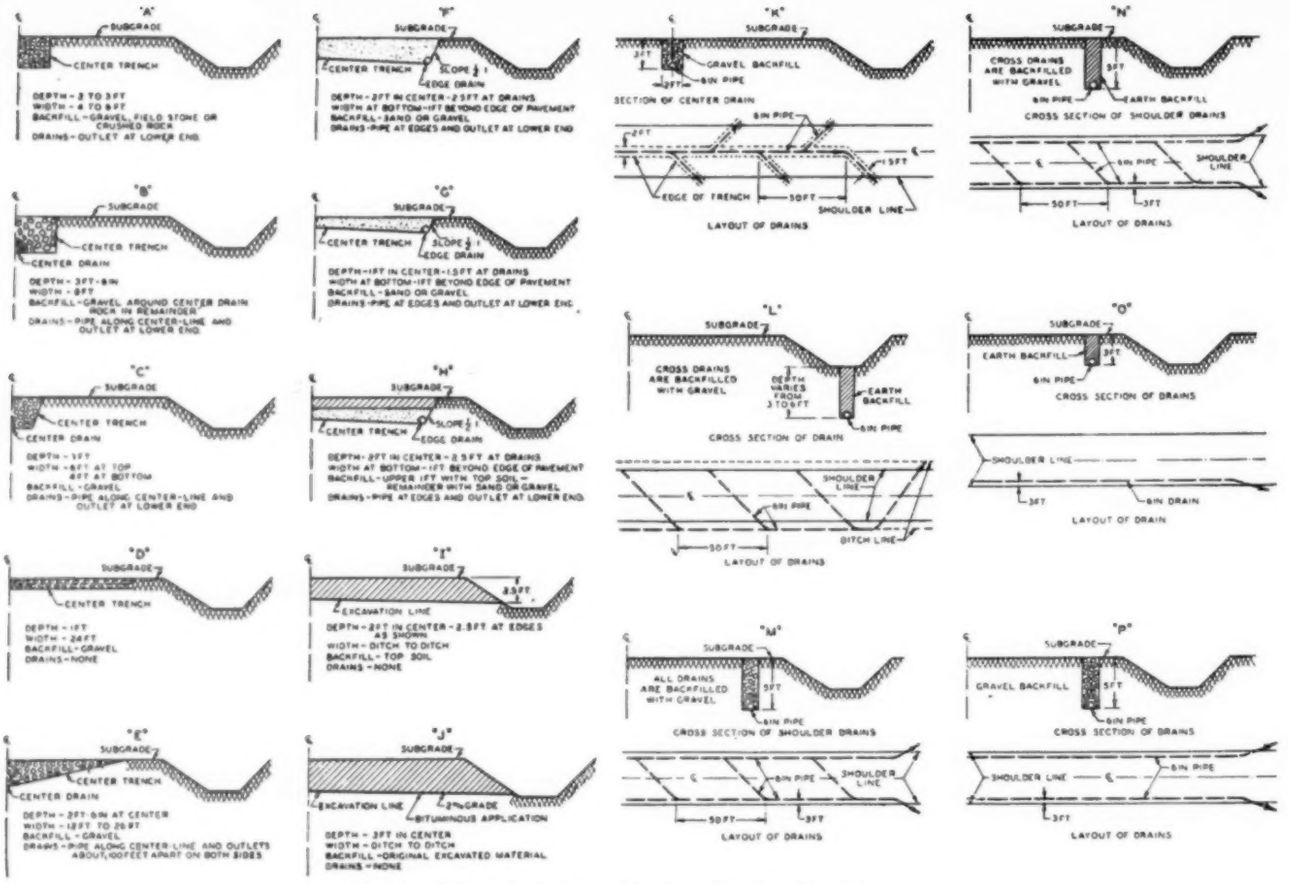

Fig. 2.—Subgrade Designs Used to Prevent Frost Heave

over the area of the excavation. The soil on the sides heaves sufficiently to crack concrete and bituminous pavements. The damage to gravel surfaces caused by the frost uplift is ironed out by maintenance after the frost leaves the ground so that there is no visible aftermath of the winter condition. These methods reduce the amount of break-up during the spring thaws and allow passage of vehicles. Compared with the results where no precautions are taken the benefits of this method are considerable.

Treatment for the full width of the traveled area as illustrated by Type *D* has proven advantageous. There

TABLE I—RESULTS OF FROST HEAVE PREVENTIVE MEASURES

Type of treatment [1]	Type of surfacing	Soil profile [2]	Results	Remarks
A	Gravel	F, D	Heaved on sides during winter; surface softens during thaw. Carries moderate amount of traffic satisfactorily	County roads; center trench 3 by 3 feet.
	Bituminous surface treatment	I, G	Heaved excessively on sides; no serious break-up during thaw.	Center trench 3 by 3 feet.
	Concrete	H	Heaved sufficiently to cause considerable cracking	Center trench 6 by 2 feet.
B	Gravel	B	Heaved a small amount on sides; no break-up	Center trench 8 by 3.5 feet.
C	do	J, L	Heaved on sides; slight softening and rutting during thaw. Carries traffic satisfactorily.	Center trench 3 feet deep, 6 feet at top, 4 feet at bottom.
	Concrete	L	Heaved on sides removing crown; considerable cracking	Do.
D	Gravel	D	No heaving observed; smooth and firm; no break-up	Trench 24 by 1 foot.
E	Bituminous surface treatment	D, I, J	Heaved on sides in soil profiles D and J; surface broken but no rutting. Heaved badly in soil profile I; no rutting.	Treatment is 12 feet wide on soil profiles D and J and 26 feet wide on soil profile I, V-type trench.
F	Concrete	A to O, inclusive	Heave negligible, very small amount of cracking	Slightly wider than pavement.
G	do	L, M	No detrimental heaving; very small amount of cracking	Do.
H	do	D, M	Heave negligible; very small amount of cracking	Do.
I	do	B, D, L, M	Heave negligible; small amount of cracking	From ditch to ditch.
J	Gravel	D	Uneven and rough; small amount of rutting; carries traffic satisfactorily.	Do.
	Concrete	B	Slight amount of heaving; fairly uniform; small amount of cracking.	Do.
K	Bituminous surface treatment	N	Heaved on sides of trenches leaving a narrow depression along the center line and over cross trenches; reduced surface break-up.	Rough riding and dangerous at times.
L	Gravel	D	Reduced break-up in most cases so that traffic could move across, although difficult; some sections impassable.	Very unsatisfactory in this soil condition.
	Concrete	D	Considerable cracking typical of frost heave	
M	Gravel	I	Impassable during thaw	This method apparently of no value in this soil.
	Concrete	C, E	Heave negligible; small amount of cracking	Depth of drains and location of cross drains varied to conform with soil profile.
N	Gravel	D	Soft and rutted in spots during thaw; carries traffic with difficulty.	
O	do	D	Impassable during thaw	No benefit derived from this method.
P	Bituminous surface treatment	D	Heaved breaking surfacing; carried traffic without breaking through.	
	Concrete	K	Heaved and cracked considerably	One section heaved to such an extent that the pavement had to be replaced.

[1] *Refers to Designs in Fig. 2.* [2] *Refers to Soil Profiles in Fig. 1.*

was no noticeable difference between the riding qualities of the surface laid over this type of treatment and adjacent sections where heaving had always been absent. The entire roadway remained smooth and firm during the spring thaw.

The V-type trench (Type *E*, Table I) is very popular because it can be excavated with a blade grader, which materially reduces the cost of excavation. In most cases surfaces laid over subgrades so treated carry traffic in a satisfactory manner. However, the heaving at the sides of the trench 12 ft. wide in soil profiles *D* and *J* and the general heaving in the trench 26 feet wide in soil profile *I* has, in some cases, developed to the point where driving is safe only at very low speeds. The surfacing in the heaved area is badly broken.

Measures F, G, H, and *I* have proved satisfactory and reliable methods of preventing detrimental frost heave of concrete pavements. Except under the extreme climatic conditions of the northern parts of Michigan and Wisconsin, heaving is negligible in treatments where the excavation and backfill is not less than 2 ft. Noticeable but uniform heave has been measured in treatments 1 ft. deep.

The method of excavating the heaving material for the entire width of the roadway, treating the base of the excavation with a bituminous material and replacing the excavated material (Type *J*, Table 1) has not been quite as successful as the full width treatments described above. Gravel surfaces on bituminous treated soils have become uneven and rough and cut up during the spring thaw. The heaving of a concrete pavement is noticeable but fairly uniform. Cracking is more pronounced than in the locations where a selected back-fill material was substituted for the excavated frost heaving soil.

The various kinds of treatment should not end abruptly but should be tapered or feathered out. According to observations by Andrew Seifert, concrete pavements laid on gravel back-fill tapered from 10 to 25 ft. cracked considerably and became noticeably rough. Fifty-foot tapers have been more satisfactory.

Table I shows that the drainage types *L* to *P*, inclusive, have been of practically no benefit in preventing heaving of soils. In most cases the drains have been placed at arbitrary depths of 3 to 6 ft. without regard to the type of soil or the arrangement of the soil layers. Type *M*, when installed in water-bearing sandy soils (soil profiles *C* and *E*) in such a manner as to conform to the soil profile, served to intercept and carry away enough of the water to prevent detrimental heave. This same type, when used in the stratified silts, fine sands, and clays (soil profile *I*), was of no value whatever.

Soil Profile Must Be Considered.—However convenient it would be to be able to establish definite and invariable spacing and depth requirements for drains, the hopelessness of thus standardizing drainage design becomes increasingly apparent as research in soils, especially for engineering purposes, progresses.

Failure to obtain the desired stability is definitely attributable in many instances to the attempt to apply arbitrary standards of spacing and depth in the placing of the drains without regard to prevailing conditions

There is only one practical procedure and that is to place drains at such distances apart and at such depths as the interception and removal of offending moisture requires. And this, it can readily be seen, becomes a local problem, the solution of which depends upon such factors as the source of the water to be removed, the character of the soils comprising the different layers and the arrangement of the layers in the soil profile.

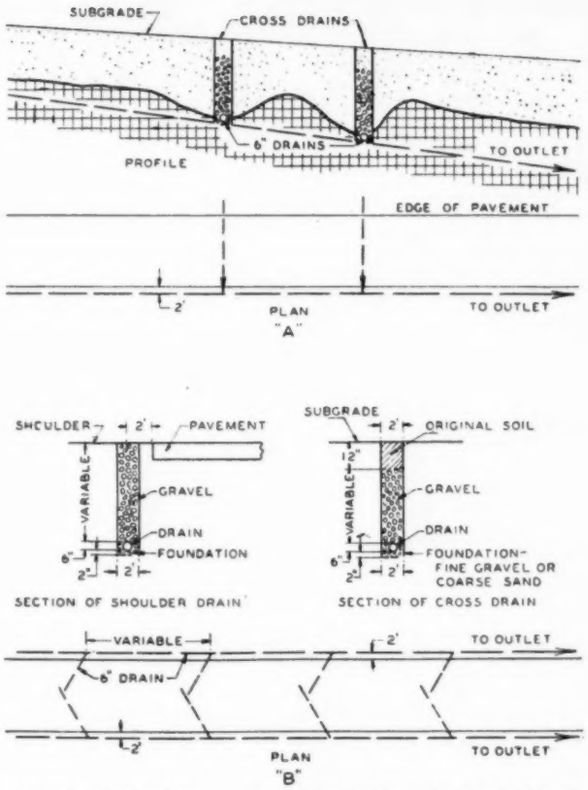

Fig. 3.—Method of Preventing Frost Heave in Drainable Soils

To further complicate the problem, some soils very readily give up their contained water and thus may be easily stabilized by drainage; other soils exercise a high affinity for moisture and are not apt to be stabilized by drainage. The only profiles found in this survey in which drainage can be reasonably certain to prevent frost heave are shown in Figures 1-*C* and 1-*E*.

Figure 3-*A* shows how drains should be placed in order to prevent frost heave in soil profiles of the type illustrated in Fig. 1-*E*. Frost heave occurring in drainable soils due to a permanent high water table (Fig. 1-*C*) may be eliminated by the system of drains shown in Fig. 3-*B*. It should be borne in mind that these methods are applicable only where the soil is more or less porous and does not possess capillarity in an appreciable amount.

Conclusions.—The following conclusions may be drawn:

1. Center trenches reduced the heave of adjacent gravel road surfacing during freezing and increased stability during thaws to some extent. As a result the damage to the road surfacing which did occur could be repaired by ordinary blading operations. These benefits are not sufficient to justify recommending narrow center trenches as a standard preventive measure. However, where scarcity of gravel makes full width treatment prohibitive, center drains 3 to 6 feet wide on the less traveled roads, and not less than 8 feet wide, or a width of one traffic lane, on the more important highways, may serve as temporary expedients prior to the construction of more permanent surfaces.

2. The measures adopted to prevent frost heaving of concrete road surfaces should be effective over an area extending not less than 1 ft. beyond the edge of the pavement and to a depth of not less than 2 ft. Excavation for the entire width of roadway and back-filling with selected material is preferable to the use of drains in excavated trenches.

3. The same preventive measures should be adopted

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American Floor Surfacing Machine Co.
TOLEDO, OHIO

for bituminous road surfaces as are employed for concrete road surfaces.

4. A porous granular material of the A-3 soil group should be substituted for excavated frost-heave soil. In locations where the cost of this type of material is excessive, topsoil may be used. The topsoil should be carefully selected from weathered soil layers and should be free from accumulations of lime.

5. Drains do not prevent frost heave in typical frost-heave soils such as the silts, silt loams, silty clays, and silty clay loams. According to the results of tests, most of these soils possess the physical properties of the group A-4 soils.

6. Frost heave caused by blocked drains or a high water table in porous A-3 soils may be prevented by the installation of drains. A thorough investigation of the soil conditions at each location should be made and the drainage system designed accordingly.

7. Frost heaving in profiles *C* and *E* (Fig. 1) may be prevented by drainage. In order to eliminate detrimental frost action under the conditions represented by the remainder of the profiles, the frost-heaving soils should be excavated (or grade line raised) and selected materials placed beneath the surfacing. The type of treatment should be governed by the permanence of the surfacing and the traffic requirements.

8. Information furnished by soil surveys, made prior to construction, should be utilized in fixing highway grades in such a manner as to correct the deficiencies of the natural soil profiles, with artificially constructed soil profiles. This practice will result in greater economy than the correction of defects in the subgrade after the grading and surfacing have been completed.

Weathering Tests on Concrete

In a paper presented at the last annual meeting of the Highway Research Board, L. O. Hanson of the University of Wisconsin, gave results of tests to determine the effect of amount of mixing water and types of coarse aggregate on the durability of concrete. The concretes were designed with three water-cement ratios, 0.65, 0.85, and 1.10 by volume, each with two slúmps of 2 inches and 7 inches. Four widely differing crushed limestones were used as coarse aggregates. Alternate freezing and thawing was used as a weathering test both on the concrete and on samples of crushed limestone. In addition, the crushed rock was given 5 and 10 cycles of a slightly modified A. S. T. M. soundness test with sodium sulfate. The specimens of concrete were 4 x 6 x 18 inch beams and 6 x 12 inch cylinders. Indications from the tests are, in part: Weathering resistance of the concrete decreased with increase in water-cement ratio and increased with additional length of curing period. The quality of the coarse aggregate was directly reflected in the resistance to freezing and thawing of the concrete. Freezing and thawing tests and the sodium sulfate test on the limestones graded the rocks in the same relative order of durability, 25 to 100 cycles of freezing and thawing being roughly duplicated respectively by 5 and 10 cycles of the sodium sulfate test.

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HIGHWAY RESEARCH BOARD TO MEET IN DECEMBER.—Roy W. Crum, Director of the Highway Research Board, announces that Dec. 6 and 7, 1934, have been named as the dates of the 14th annual meeting of the board. As usual the meeting will be held at the building of the National Research Council and National Academy of Sciences in Washington, D. C.

New Equipment and Materials

New Concrete Grinder

A machine new in principle that is claimed to cut concrete surfaces at exceptionally low cost and speed and accuracy has been placed on the market by the American Floor Surfacing Machine Co., 531 South St. Clair St., Toledo, O. The machine is driven by a gasoline engine and has a dust collecting system that removes the large volume of dust as the concrete is ground so that the cutting head is always working on a clean surface. The cutter head rotates at a high speed and the cutters do their work at a rapid rate which

New Concrete Surfacing Machine

is due to placing them around the cylindrical surface of the cutter head. The rotary action of the cuteer head placed in a horizontal position gives a smooth, keen cutting action. The machine is perfectly balanced on two truck wheels and requires practically no effort to operate. The large truck wheels also make easy portability over the highway.

The cutter head is made of two heavy sections of steel arranged so that a new set of cutters can easily be assembled in place. The cutters are made of hardened, high grade steel and are of the star wheel type, 72 being in each assembly. The pressure on the cutter head is regulated by an adjustable weight, and it is stated the right amount of pressure can be maintained at all times for rapidly cutting hard or soft concrete surfaces.

It is stated that a total of 172 bumps ranging from small to large in a 3-mile section of new laid concrete road were ground down to a perfect level in just 14 hours with this machine.

▼

New Truck and Bus Tire

A newly developed truck and bus tire, with improvements over previous construction, is announced by The B. F. Goodrich Company as now ready for sale through its nation-wide dealer organization. The new tire known as the Goodrich triple protected Silvertown has three new protection features, Plyflex, Ply-lock and 100 per cent full floating cords, the manufacturer says.

Plyflex is a new, tough, sturdy rubber material and the new tire has a layer of it protecting the side-wall. It bears the brunt of the strains caused by the tire flexing several hundred times a minute, distributes stresses throughout the carcass and prevents local weakness.

Ply-lock is a new process of locking the continuous plies of the tire around the bead, anchoring them in place and floating the tapered ply ends in rubber. Its use prevents the plies tearing loose just above the bead, a trouble often found in tires using short reinforcement plies, instead of this new type construction.

Full floating cord fabric used in the new product is completely "floated-in-rubber," so that every cord is entirely surrounded by rubber. This process, it is claimed, makes it possible to extend the life of the tire, since it runs cooler due to the absence of friction causing cross-cords.

Two other new products, the Gold and Black tube which offers greater resistance to tear and rim chafing and the Seal-O-Matic safety tube, an utterly new type puncture sealing tube for passenger cars, also have been announced by Goodrich in the last several weeks.

▼

Improved Type Wagon Drill

For facilitating the drilling of deep drill holes in quarries and general rock excavation, the Worthington Pump & Machinery Corporation, Harrison, N. J., has recently announced the addition of an improved type wagon drill to its extensive line of rock drills.

The new machine incorporates an adjustable drill steel centralizer, an exclusive fea-

New Worthington Wagon Drill

ture with Worthington, which is claimed to greatly reduce the time and labor necessary in collaring the drill holes. Another innovation is the leveling device permitting the adjustment of the drill tower to the vertical position when the rig is set on uneven ground, thus eliminating blocking up of the wheels. Worthy of note is the fact that the drilling engine can be readily demounted from its detachable feed slide and the slab back guide by the removal of two bolts, in no way disturbing the slab back. The machine can be furnished with either an air hoist or a hand winch for raising or lowering the drilling engine and either a hand winch or block and fall for handling the drill steel.

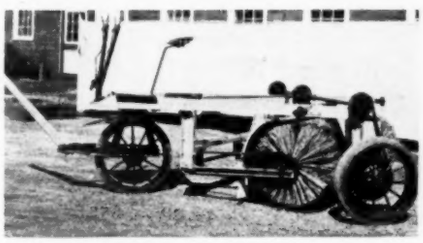
While the standard type is built with three wheels, it can also be furnished with four, for running on transverse track. The three or four wheeled machine is constructed to be converted to skid type if desired. The drilling engine can be furnished for either light or heavy, wet or dry drilling.

A copy of Bulletin W-1200-B6 describing this machine in detail will be sent upon request.

▼

New Street Sweeper

A new rubber tired street sweeper mounted on a 3-wheel chassis has been placed on the market by the Universal Road Machinery Co., Kingston, N. Y. In this machine a new method is used for raising and lowering the broom, with cables operating through sheaves, providing quick, easy and positive control.



New 3-Wheel Rubber Tired Street Sweeper

The broom is mounted diagonally across the frame at the point usually occupied by the rear axle, instead of back of the axle, so that no counterweight is required. The frame is of an all steel construction, of great strength and durability, but because of the special design is considerably lighter. The broom is engaged or disconnected as desired, through a jaw type clutch, and the control levers for clutch and broom raising device are within easy reach of the operator. The clutch is held firmly in position when operating the broom, by a heavy coil spring provided for this purpose.

▼

New Pavement Core Drill

A core drilling outfit for mud jack work has been developed by the Sullivan Machinery Co., 400 North Michigan Ave., Chicago, Ill. This drill consists of a rotary mechanism arranged with a ratchet feed to force the core barrel into the concrete. A core barrel is screwed to the spindle, the bottom end of the barrel being notched so that it will roll over shot. The shot is fed down through a cup at the top of the core barrel as is likewise the water circulation. The rotary mechanism is driven by a gasoline engine and the water tank is provided for carrying a supply of circulation water. All of this mechanism is mounted on a four wheel hard rubber tire truck, which is self propelled by chain drive from the gasoline engine.

Core Drill for Mud Jack Work

In tests thus far run it has been found that the average length of time required to drill a hole through 9 ins. of pavement is approximately 5½ minutes through concrete in which limestone gravel was used as aggregate, and re-enforced with steel. When chert or flint gravel are used as aggregate, the time is seven to eight minutes. The core drill may also be used to take sample cores of pavements for inspection of the structure, materials and thickness, and analysis by crushing tests.

New Power Take-Off, Power Controlled Elevating Grader

The new power take-off, power controlled elevating grader has been announced by Caterpillar Tractor Co., Peoria, Ill. The new model features power operated controls; a 48-in., shaft-driven carrier; wide drum-type wheels; extensible axles, enclosed gear drives; and wheels, drive shafts, drums and belt rollers mounted on ball or roller bearings. Power is supplied to the carrier, operating controls and improved pan cleaner by a rear power take-off on the tractor.

New "Caterpillar" Power Take-Off, Power Controlled Elevating Grader

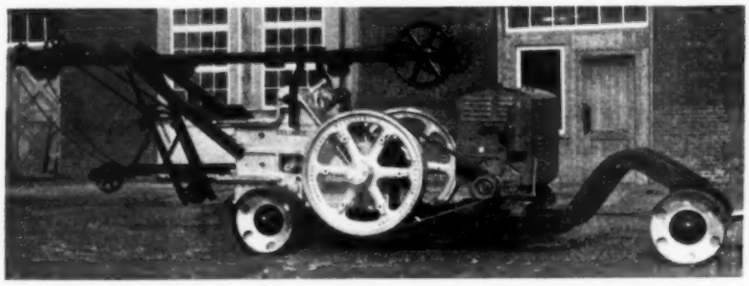
From his comfortable seat directly over the plow, the operator has an unobstructed view of the furrow, the belt, the wagons and the tractor driver. Every working adjustment of both plow and carrier is made by a touch of his hand on the four power control levers grouped within easy reach.

This new elevating grader is designed especially for the "Caterpillar" Diesel Seventy-Five Tractor, but it may also be used with the Seventy, the Diesel or gasoline Fifty, or the Sixties. These new machines may be equipped with 19, 22, or 25-ft. carriers, and when so equipped have shipping weights of 17,300, 17,840, and 18,340 lbs., respectively.

New Portable Crushing Unit

A new portable crushing unit with crushed and power mounted on a single truck has been brought out by the Universal Road Machinery Co., Kingston, N. Y. The crusher is operated through a V-belt drive, no belt tightener being required.

The outfit is designed particularly for road maintenance, where a crusher is to be hauled along the road continuously, using fieldstone or old stone walls for crushing, and simply leaving the stone in small piles or windrows alongside the road for use. It is built very low to the ground so that it is easy to feed, and is mounted on heavy substantial disc wheels with a wide tire, and fitted with Timken roller bearings so that it is exceptionally easy to haul. The crushers can be furnished with or without folding elevators as desired, and are proving exceptionally popular.



Traveling Crusher with Elevator Lowered for Transportation

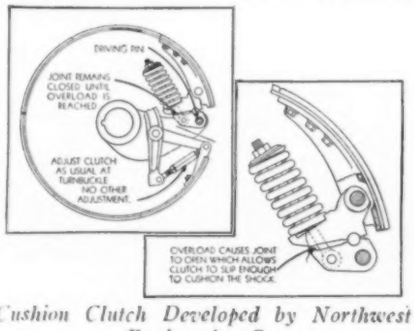
Northwest Develops Cushion Clutch

Old time operators will remember how the steam in the cylinder acted as a cushion and gave a few more seconds' time to ease up on the throttle before a cable snapped or dipper stick gave way when the dipper hooked under an immovable load.

Engineers of the Northwest Engineering Co., Chicago, Ill., builders of gasoline, oil and electric powered shovels, cranes, and draglines, have developed a clutch that permits the machine to retain its great power and gives it the cushion of steam. This device is now being offered on the larger sizes of Northwest machines.

The cushion clutch is an overload release in the main clutch of the hoist drum. It is claimed that no matter how tightly it is adjusted it limits the hoist rope pull to a definite value. With the cushion clutch the full power of the engine is transmitted to the operating functions, but maximum stresses on every part under power are reduced when the hoist rope is tensioned. The natural result is a reduction in maximum loads on the drum shaft, a reduction in clutch adjustment and increased cable life.

In operation, it acts as a cushion against the shocks, permitting the main clutch to gently slip when the overload point is reached. This is stated to give the operator from three to five times as long to throw out the main clutch lever to prevent the engine stalling.


DRIVING PIN
JOINT REMAINS CLOSED UNTIL OVERLOAD IS REACHED
ADJUST CLUTCH AS USUAL AT TURNBUCKLE NO OTHER ADJUSTMENT
OVERLOAD CAUSES JOINT TO OPEN WHICH ALLOWS CLUTCH TO SLIP ENOUGH TO CUSHION THE SHOCK

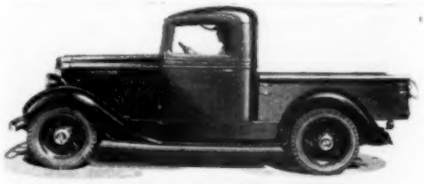
Cushion Clutch Developed by Northwest Engineering Co.

New ½-Ton International Truck

In the design of the new Model C-1, ½ ton six-cylinder International motor truck, special consideration has been given to the ever-increasing demand for pleasing lines and color combinations. A sloping V-shaped radiator with polished stainless steel molding and satin-finish aluminum grilles, deeply crowned and valanced fenders, streamline hood and cowl all help to make this new C-1 a most attractive-looking light hauling unit.

The wheelbase of 113 in. is especially suited for light delivery bodies. Sturdiness of construction is enhanced by a deep frame which is reinforced by numerous cross members. The cam-and-lever-steering gear, roller bearing anti-friction joints, hydraulic pressure-gun chassis lubrication and chrome molybdenum steel axle shafts are noteworthy chassis features that make for safety and economical operation.

The engine of the new Model C-1, ½ ton



New International ½ Ton Truck